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Dr Francis.

"From the Authors."

MANUAL
OF THE
MINERALOGY
OF
GREAT BRITAIN AND IRELAND.

MANUAL

OF THE

MINERALOGY

OF

GREAT BRITAIN AND IRELAND.

BY

ROBERT PHILIPS GREG, F.G.S.,

AND

WILLIAM G. LETTSOM.

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PREFACE.

It has been the earnest endeavour of the Authors of the present work to place the Mineralogy of Great Britain and Ireland on that footing to which scientifically and economically it is entitled: they have enjoyed unusual opportunities and facilities in compiling a work of this kind, and have received every advice and assistance from those most conversant with the subject, both locally and generally; and they trust it may be advantageously consulted for information respecting the many beautiful and rare mineral-species (in number not less than 240, *exclusive* of varieties and sub-species) which have been met with in the United Kingdom; their characters, uses, crystalline forms, and, above all, the localities where they have either formerly been or are now found.

Though much of the matter has necessarily been compiled from general sources, a large portion is strictly original, no trouble having been spared in giving the crystalline forms and localities as fully and clearly as possible; while in the chemical department it is hoped that as much new and correct information may be derived as could be expected in a work having a local, and therefore in some degree a limited character.

A considerable number of species (between 30 and 40) *new* to Great Britain, a number of new forms and measurements, and an immense number of new localities, are now published for the first time. Statistical and other useful information relative to mines, or the minerals and ores extracted from them, as *Coal, Iron, Lead, Copper, Salt,* &c., are appended, as well as a list of British *pseudomorphs* and *meteorolites.*

The work is illustrated by 400 woodcuts, representing the most recent, interesting and characteristic crystalline forms, met with in the United Kingdom. Exclusive of *calcareous spar* (whose almost endless forms no attempt has here been made to enumerate), between 700 and 800 crystalline forms are described, expressed either by figures or by face-letters in combination (as M P *l a y o k*, in topaz from the Mourne Mountains, Ireland), *almost* every known British form being in fact given; this being the first instance of such an attempt having been made on so complete a scale; and, as much time and labour have been bestowed upon it, the Authors trust that their efforts may not have been entirely thrown away, or prove altogether useless to Mineralogy generally.

The *italic letters* used in the figures and text for expressing crystalline planes or the faces of crystals, are precisely those adopted by Brooke and Miller in their edition of Phillips's 'Mineralogy,' so far, at least, as *secondary* planes are concerned; it has, however, here been considered more advisable employ *capital letters* to express more clearly the *primary* fo (as M for *m*, P for *c, p, r,* &c.; T for *t*).

Wherever possible, the angular values, or measurem given by Brooke and Miller, have been employed,—red however, to the natural angles.

In the chemical formulæ, the German plan of using *barred* letters are employed (as $\overset{..}{\mathrm{F}\!\!\!\!-}\mathrm{e}$) for expressing *double* atoms.

The Authors need hardly add, that the work having a local, and therefore a limited character, they are saved the necessity of writing a complete treatise on the subject, or of giving any fuller introduction than the present prefatory remarks; it being, of course, assumed that their readers are already provided with works treating the subject *ab initio*, and more extensively.

Dr. Heddle has kindly undertaken the general, and especially the chemical revision of this work, preparatory to its going through the press; and the Authors take this opportunity of acknowledging the great obligations they are under to that gentleman.

The following mineralogical collections have been inspected or consulted; viz. that in the British Museum; the late Mr. C. H. Turner's; Mr. Greg's (comprising the late Mr. Allan's); Mr. Nevill's, formerly Mr. W. G. Lettsom's; the late Mr. H. J. Brooke's; Dr. Heddle's of Edinburgh; that of the Edinburgh University's Museum; those respectively of Belfast, Manchester, Worcester, and Jermyn Street, London; as well as that of the late Dr. Thomson of Glasgow.

The Authors are under personal obligations for information, &c., to Mr. Brice Wright, now of Great Russell Street, London, for a very complete list of Cumberland localities; to Mr. R. Talling of Lostwithiel, for East Cornish localities; to Mr. Garby of Redruth, to Mr. Mitchell of Truro, to Mr. Lavin of Penzance, for West Cornish localities; and to Dr. Forster Heddle of Edinburgh, for Scotch localities and crystalline forms, for many analyses, especially of zeolites, as well as for much general information.

Also more generally to Dr. Traill and to Mr. Alex. Rose of Edinburgh; the Rev. Mr. Morgan of Stonehaven, Kincardineshire (for Aberdeenshire localities); the late Thomas Brown, Esq., of Lanfine House, Ayrshire; H. Bullen, Esq., of Tavistock; John Taylor, Esq., F.R.S., of London; Professor Tennant of London; Professor R. D. Thomson, now of London; Mr. W. Sanders of Bristol; G. W. Ormerod, Esq., late of Manchester; Campbell White, Esq., Jersey; Professor Miller of Cambridge; Mr. J. W. Mallet, formerly of Dublin; Mr. P. Doran of Dublin; the late H. J. Brooke, Esq., F.R.S.; Mr. J. Cooper of Keswick; Professor J. Dana of New Haven, Connecticut, U.S.; Dr. Krantz of Bonn; Dr. Bondi of Dresden; Mons. A. Descloiseaux of Paris; and to Dr. W. Francis of London.

A list of most of the Cornish mines referred to is, for the sake of convenience, given separately at the end, and their locality expressed, by stating the nearest market town or parish.

List of Works referred to in the present Manual.

Brooke and Miller's New Edition of Phillips's Mineralogy (1852).
Phillips's Mineralogy (1823).
Allan's Phillips's Mineralogy (1837).
Dana's System of Mineralogy, Fourth Edition.
Allan's Manual of Mineralogy (1834).
Sowerby's British Mineralogy (1801?).
Nicol's Manual of Mineralogy (1849).

Dr. Thomson's Outlines of Mineralogy (1836).

Hausmann's Handbuch der Mineralogie (1847).

Dr. Rammelsberg's Handwörterbuch der Mineralogie (1841-1856).

Gustav Rose's Krystallo-chemische Mineralsystem (1853).

Professor Kobell's Mineralogie (1853).

Dufrénoy's Traité de Mineralogie (1845), (1856).

The Mining Almanack (1849).

Sopwith's Account of the Museum of Economic Geology in Jermyn Street.

Portlock's Geological Report and Survey of the N.E. of Ireland (1843).

Catalogue of the British Museum.

Sale Catalogue of Phillips's Collection of Minerals.

Sale Catalogue of Sirr's Collection in Dublin (1841).

MS. Catalogue of Allan's Collection.

Levy's Catalogue of the Turner Collection (1837).

Illustrated Catalogue of the Great Exhibition (1851).

Catalogue of the Minerals in Trinity College, Dublin (1850).

Lectures on the Results of the Great Exhibition.

Gems of the Peak, by W. Adam of Matlock.

Hogg's Business Man's Note Book (1857).

Garby's List of Cornish Localities, published in the Transactions of the Royal Geological Society of Cornwall.

Quarterly Journals of the Geological Society of London.

London and Edinburgh Philosophical Magazine.

Edinburgh New Philosophical Journal.

Silliman's American Journal.

Poggendorff's Annalen.

The Volumes of the British Association Reports.

Sharp's British Gazetteer, &c.

GENERAL CLASSIFICATION

AND

TABLE OF ORDERS AND SPECIES.

CLASS I. NON-METALLIC MINERALS.

ORDER I. **Carbon.**

Genus 1. CARBON.
- 1. Graphite.
- 2. Coal.
  - *a.* bituminous coal.
  - *b.* non-bituminous coal.
  - *c.* brown coal, &c.

ORDER II. **Water.**

Genus 1. WATER.
- 3. Ice.

ORDER III.—**Resin.**

Genus 1. RESIN.
- 4. Amber.
- 5. Copaline.
- 6. Middletonite.
- 7. Retinite.
- 8. Schleretinite.
- 9. Burytite.
- 10. Bitumen.
  - *a.* Naphtha.
  - *b.* Petroleum.
  - *c.* Elaterite.
  - *d.* Asphaltum.
- 11. Torbanite.
- 12. Ozocerite.
- 13. Hatchetine.

ORDER IV. **Sulphur.**

Genus 1. NATIVE SULPHUR.
- 14. Sulphur.

ORDER V. **Fluorine.**

Genus 1. FLUORIDES.
- 15. Fluor-spar.
- 16. Fluellite.

ORDER VI. **Chlorine.**

Genus 1. CHLORIDES.
- 17. Rock-salt.
- 18. Sal-ammoniac.

ORDER VII. **Carbonates.**

Genus 1. ANHYDROUS CARBONATES.
- 19. Arragonite.
- 20. Calcite, &c.
- 21. Strontianite, &c.
- 22. Witherite.
- 23. Barytocalcite.
- 24. Alstonite.
- 25. Dolomite.
- 26. Breunnerite.
- 27. Ankerite.

Genus 2. HYDROUS CARBONATES.
- 28. Hydrocalcite.
- 29. Trona.
- 30. Hydromagnesite.

ORDER VIII. **Silica.**

Genus [illegible]
- 31. [illegible]

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21. Strontianite, &c.
22. Witherite.
23. Barytocalcite.
24. Alstonite.
25. Dolomite.
26. Breunerite.
27. Ankerite.

Genus 2. HYDROCARBONATES.

28. Hydrocalcite.
29. Pennite.
30. Hydromagnesite.

ORDER VIII. **Oxides.**

Genus 1. HYDROUS OXIDE.

31. Brucite.

ORDER IX. **Sulphates.**

Genus 1. ANHYDROUS SULPHATES.

32. Anhydrite.
33. Barytes.
34. Celestine.
35. Mascagnine.
36. Epsomite.
37. Alum.
38. Gypsum.
39. Websterite.

ORDER X. **Phosphates.**

Genus 1. ANHYDROUS PHOSPHATES.

40. Apatite.

Genus 2. HYDROUS PHOSPHATES.

41. Wavellite.
42. Childrenite.

ORDER XI. **Silex and Silicates.**

Genus 1. SILICA.

43. Quartz, &c.
44. Opal, &c.

Genus 2. ANHYDROUS SILICATES.

Group 1. ALUMINOUS SILICATES.

45. Garnet, &c.
46. Idocrase.
47. Epidote, &c.
48. Zoizite ?.
49. Felspar.
50. Labradorite, &c.
51. Albite.
52. Saussurite ?.
53. Muscovite.
54. Biotite.
55. Staurolite.
56. Andalusite, &c.
57. Kyanite.
58. Beryl.
59. Spodumene.
60. Killinite.
61. Obsidian, &c.
62. Isopyre.
63. Iolite (Cordierite).

Group 2. NON-ALUMINOUS SILICATES. ANHYDROUS SILICATES.

64. Zircon.
65. Olivine.
66. Gadolinite.
67. Allanite.
68. Wollastonite.
69. Augite, &c.
70. Bronzite.
71. Hypersthene.
72. Diallage.
73. Babingtonite.
74. Hornblende.

Genus 3. HYDRO-SILICATES.

Group 1. ALUMINOUS HYDRO-SILICATES.

75. Natrolite.
76. Scolezite.
77. Mesolite, &c.
78. Faröelite (Mesole).
79. Thomsonite.
80. Stilbite.
81. Epistilbite.
82. Heulandite.
83. Chabasite, &c.
84. Gmelinite.
85. Levyne.
86. Laumonite.
87. Phillipsite.
88. Brewsterite.
89. Analcime.
90. Harmotome.
91. Edingtonite.
92. Weissigite ?.
93. Prehnite.
94. Allophane.
95. Chlorite.
96. Aphrosiderite.
97. Kämmererite.
98. Margarodite.
    - *a.* Nacrite.
    - *b.* Gilbertite.
    - *c.* Talcite.
99. Talc-steatite.
100. Lithomarge.

101. Saponite.
102. Kaolin.
103. Pinite.

Group 2. Non-Aluminous Hydro-Silicates.

104. Apophyllite.
105. Pectolite.
106. Gyrolite.
107. Serpentine, &c.

Genus 4. Silicates with Fluorides.

108. Topaz.
109. Chondrodite.
110. Lepidolite.

Genus 5. Silicates with Borates.

111. Tourmaline.
112. Datholite.
113. Axinite.

Order XII. **Alumina and Aluminates.**

Genus 1. Alumina.

114. Corundum.

Genus 2. Aluminates.

115. Spinel.

Class II. METALLIC MINERALS.

Order I. **Gold.**

Genus 1. Native Gold.

116. Gold.

Order II. **Silver.**

Genus 1. Native Silver.

117. Silver.

Genus 2. Sulphide.

118. Argentite.

Genus 3. Sulphide in Combination.

119. Pyrargyrite.

Genus 4. Chloride.

120. Horn-silver (kerate).

Order III. **Platinum.**

Genus 1. Native Platinum.

121. Platinum.

Order IV. **Iron.**

Genus 1. Native Iron.

122. Metallic iron (meteoric).
Appendix. Meteoric stones.

Genus 2. Oxides.

123. Hematite (specular iron).
124. Magnetite.

Genus 3. Oxide in Combination.

125. Göthite.
126. Limonite.
127. Siderite.
128. Ilmenite.
129. Iserine.
130. Cronstedtite.
131. Vivianite.
132. Scorodite.
133. Pharmacosiderite.
134. Beudantite.
135. Melanterite.
136. Iron alum.
137. Fayalite.
138. Chlorophæite.
139. Green earth.
    a. Glauconite.
    b. Kirwanite.
140. Pitticite.

Genus 4. Sulphides.

141. Pyrites.
142. Marcasite, &c.
143. Pyrrhotine.

Genus 5. SULPHIDE IN COMBINATION.

144. Mispickel.

ORDER V. **Manganese.**

Genus 1. OXIDES.

145. Pyrolusite, &c. (Varvicite).
146. Manganite.

Genus 2. OXIDE IN COMBINATION.

147. Psilomelane.
148. Wad.
149. Diallogite.
150. Rhodonite.

ORDER VI. **Nickel.**

Genus 1. OXIDE.

151. Annabergite.

Genus 2. OXIDE IN COMBINATION.

152. Emerald nickel.

Genus 3. SULPHIDE.

153. Millerite.

Genus 4. SULPHIDE IN COMBINATION.

154. Eisen-nickelkies.

Genus 5. ARSENIDE.

155. Nickeline (kupfernickel).

ORDER VII. **Cobalt.**

Genus 1. OXIDE IN COMBINATION.

156. Asbolane.
157. Erythrine.

Genus 2. ARSENIDE.

158. Smaltine.

Genus 3. ARSENIDE IN COMBINATION.

159. Cobaltine.

ORDER VIII.

Genus 1. NATIVE COPPER.

160. Copper.

Genus 2. OXIDES.

161. Cuprite.
162. Melaconite.
163. Pitchy copper.

Genus 3. OXIDE IN COMBINATION.

164. Malachite.
165. Chessylite.
166. Liroconite.
167. Tamarite.
168. Clinoclase.
169. Olivenite.
170. Cornwallite.
171. Erinite.
172. Libethenite.
173. Lunnite.
174. Blue vitriol.
175. Brochantite.
176. Chrysocolla.

Genus 4. ARSENIDE.

177. Condurrite (Domeykite).

Genus 5. SULPHIDES.

178. Copper glance.
179. Kupferindig (Covelline).

Genus 6. SULPHIDE IN COMBINATION.

180. Tennantite.
181. Tetrahedrite.
182. Chalcopyrite.
183. Erubescite.
184. Bournonite.

Genus 7. CHLORIDE IN COMBINATION.

185. Connellite.

ORDER IX. **Molybdenum.**

Genus 1. OXIDE.

186. Molybdenine.

Genus 2. SULPHIDE.

187. Molybdenite.

ORDER X. **Tungsten.**

Genus 1. OXIDE.

188. Tungstic ochre (Wolframine).

Genus 2. OXIDE IN COMBINATION.

189. Scheelite.
190. Wolfram.

ORDER XI. **Tin.**

Genus 1. OXIDE.

191. Cassiterite.

Genus 2. SULPHIDE IN COMBINATION.

192. Stannine.

ORDER XII. **Titanium.**

Genus 1. OXIDES.

193. Rutile.
194. Anatase.
195. Brookite.

Genus 2. OXIDE IN COMBINATION.

196. Sphene.

ORDER XIII. **Arsenic.**

Genus 1. NATIVE ARSENIC.

197. Arsenic.

Genus 2. OXIDE.

198. Arsenite.

ORDER XIV. **Antimony.**

Genus 1. OXIDE IN COMBINATION.

199. Kermes (Red antimony).
200. Cervantite.
201. Antimony ochre (Stiblite).
202. Bleinierite.

Genus 2. SULPHIDES.

203. Antimonite.
204. Berthierite.

ORDER XV. **Bismuth.**

Genus 1. NATIVE BISMUTH.

205. Bismuth.

Genus 2. OXIDE.

206. Bismuth ochre.

Genus 3. SULPHIDE.

207. Bismuthine.

Genus 4. TELLURIDE.

208. Daphyllite (Tetradymite).

ORDER XVI. **Uranium.**

Genus 1. OXIDE IN COMBINATION.

209. Uran-ochre (Zippeite).
210. Pitchblende.
211. Chalcolite (Uranite).
212. Autunnite.

ORDER XVII. **Lead.**

Genus 1. NATIVE LEAD.

213. Lead ?.

Genus 2. OXIDES.

214. Minium.
215. Plattnerite ?.

Genus 3. OXIDE IN COMBINATION.

216. Cerussite.
217. Anglesite.
218. Linarite.
219. Leadhillite.
220. Susannite.
221. Lanarkite.
222. Caledonite.
223. Pyromorphite, &c.
224. Mimetite.
225. Vanadinite.
226. Stolzite.
227. Wulfenite.

Genus 4. SULPHIDE.

228. Galena.

Genus 5. SULPHIDE IN COMBINATION.

229. Jamesonite.
230. Kilbrickenite (Geocronite).

Genus 6. Chloride in Combination.

231. Mendipite.
232. Matlockite.
233. Cromfordite.

Order XVIII. Zinc.

Genus 1. Oxide in Combination.

234. Calamine.
235. Aurichalcite.
236. Smithsonite.
237. Goslarite.

Genus 2. Sulphide.

238. Blende.

Order XIX. Cadmium.

Genus 1. Sulphide.

239. Greenockite.

Order XX. Chromium.

Genus 1. Oxide.

240. Chrome oxide.

Genus 2. Oxide in Combina

241. Chromite.

SUPPLEMENT.

1. Apjohnite.
2. Agalmatholite.
3. Bole.
    - *a.* Erinite.
    - *b.* Rhodalite.
    - *c.* Fuller's-earth.
    - *d.* Rock-soap.
4. Calcareo-sulphate of barytes.
5. Calcareo-sulphate of strontian.
6. Doranite.
7. Leedsite.
8. Mineral charcoal.
9. Nitro-calcite.
10. Pipe-clay.
11. Potter's clay.
12. Pigotite.
13. Plinthite.
14. Rotten-stone.
15. Scarbroite.
16. Stannite.
17. Supersulphuret of lea (Johnstonite).
18. Tuesite.
19. Verrucite.

A MANUAL

OF

BRITISH MINERALOGY.

Class I. NON-METALLIC MINERALS.

Order I. CARBON.

1. **GRAPHITE.—Black Lead. Plumbago. Carburet of Iron.**

Hexagonal. In flat six-sided tables. Cleavage basal, perfect. Usually in imbedded, foliated, or granular masses. Lustre metallic. Streak black and shining. Colour dark steel-grey. Opaque. Sectile. Soils paper. Thin laminæ flexible. Feel greasy.

Before the blowpipe, and with reagents, infusible, but burns with difficulty. Insoluble in acids, which only act upon the iron or other impurities.

Composition : C, carbon, mixed with a variable proportion of iron, and small quantities of alumina, silica, lime, &c.

Analyses.

	a.	*b.*	*c.*	*d.*	*e.*
Carbon .	90·0	92·0	96·0	94·4	98·9
Iron .	9·0	8·0	4·0	1·4 ($\dot{Fe}$)	—
				2·6 ($\dddot{Si}$)	1·2 ($\dddot{Al}$)

Graphite is commonly found in primitive or metamorphic rocks, occasionally in the coal formation. It is principally used in the manufacture of lead-pencils, and of such crucibles as have to be subjected to much heat; also to diminish friction, and protect iron from oxidation.

LOCALITIES.—*England.* Cornwall; near Tuckingmill, Camborne, and in a granite quarry on Kergiliack estate near Penryn. Cumberland; at a mine near the head of Borrowdale, near Lomever, nearly exhausted; about fifty years ago, one mass was found there which yielded about 70,000 lbs. of the purer black-lead, worth, in 1843, about 30*s.* a lb. Lately a vein has been found at Bannerdale near Keswick. Plumbago, of a fair quality, has also just been found by the Rev. W. Cumming, at Beary in the Isle of Man.

Scotland. At Craigman coal-mine, near New Cumnock in Ayrshire, massive and columnar. Aberdeenshire; near the junction of the Devernon with the Bogie, not far from Huntley. Inverness; at Strathferrar near Beauly, in irregular masses, imbedded, with garnets, in gneiss. At Fetlar in the Shetlands. Island of Mull; on the estate of Killimore, two miles from the head of Loch Seriden, in detached masses of a medium quality, fit for common uses, found very near the surface of the soil.

Ireland; near Kilkenny.

Graphite is derived from the Greek, *γράφω, to write.*

2 *a*. COAL.—Common Coal. Black Coal. Mineral Coal. Bituminous Coal.

Structure compact, slaty or confusedly fibrous, often dividing into columnar, cubical, or rhomboidal fragments. Fracture conchoidal, uneven. Rather brittle and sectile. Lustre vitreo-resinous. Colour black, brown. Opaque. Sometimes iridescent. H. 1·0 to 2·5; Gr. 1·20 to 1·75. Burns readily, emitting flame and smoke, and more or less of bituminous odour. Heated in the closed tube with powdered sulphur, gives out sulphuretted hydrogen gas.

Chemical composition: carbon, with oxygen, hydrogen, nitrogen, and earthy matter in various proportions; the amount of bituminous matter amounting from 10 to 60 per cent. in different kinds. The following Table, containing the elementary analyses and economic value of various British coals, is taken from Sir H. De la Beche and Dr. Lyon Playfair's Report (Geol. Survey, vol. ii.):—

COMMON COAL.

		Spec. grav.	Car-bon.	Hydrogen.	Nitro-gen.	Sul-phur.	Oxy-gen.	Ash.	Coke per cent.	Eva-por. power.	
Welsh Coals.	1	1·375	91·44	3·46	0·21	0·79	2·58	1·52	92 9	9·46	Anthracite.
	2	1·275	89·78	5·15	2·16	1·02	0·39	1·50	77·5	10·21	Ebbw Vale.
	3	1·304	88·66	4·63	1·43	0·33	1·03	3·96	88·10	9·94	Binea Coal.
	4	1·326	88·26	4·66	1·45	1·77	0·60	3·26	84 3	10·14	Duffryn.
	5	1·358	85·52	3·72	trace	0·12	4·55	6·09	85·0	6·36	Pentrefelin.
	6	1·30	84·87	3·84	0·41	0·45	7·19	3·24	85·5	9·35	Graigola.
	7	1·32	80·70	5·66	1·35	2·39	4·38	5·52	64·8	7·47	Ponty Pool.
	8	1·34	75·15	4·93	1·07	2·85	5 04	10·96	62·5	8·84	¾ Rock vein.
	9	1·29	73 84	5·14	1·47	2·34	8·29	8·92	56·0	8·0	Coleshill.
Scotch.	10	1·277	74·55	5·14	0·10	0·33	15·51	4·37	49·8	7·08	Dalkeith jewel seam.
	11	1·316	76·94	5·20	trace	0·38	4·37	3·10	53·5	7·71	Do. coronation seam.
	12	1·20	76·09	5·22	1·41	1·53	5·05	10·70	58·45	8·46	Wallsend, Elgin.
	13	1·25	79·58	5·50	1·13	1·46	8·33	4·00	52·03	7·56	Fordel Splint.
	14	1·29	79·85	5·28	1·35	1·42	8·58	3·52	56·6	7·40	Grangemouth.
Eng.	15	1·25	81·70	6·17	1·84	2·85	4·37	3·07	59·2	7·3	Broomhill. [of Dean.
	16	1·283	73·52	5·69	2·04	2·27	6·48	10·00	57·8	8·52	Parkend, Sydney, Forest
I'sh.	17	1·59	80·03	2·30	0·23	6·76	in ash.	10·80	90·1	9·85	Slievardagh.

The following are a few foreign coals for comparison:—

	Car-bon.	Hydro-gen.	Oxy-gen.	Earthy matter.	
1	96·02	0·44	2·94	0·60	Karsten, Werden, Westphalia.
2	89·16	3·20	6·45	1·18	Do. Eschweiler Duren.
3	81·32	3·21	14 47	1·00	Do. Wellesweiler Saarbruck.
4	78·39	3·21	17·77	0·63	Do. Beuthen, Upper Silesia.
5	73·88	2·76	20·48	2·88	Do. Brzenskowitz, do.
6	89·27	4·85	4·47*a*	1·41	Regnault, Alais.
7	87·45	5·14	5·63*a*	1·78	Do. Rive de Gier.
8	84·83	5·61	6·57*a*	2·99	Do. do. Cimetière.
9	82·12	5·27	7·48*a*	5·13	Do. Lavasse.
10	76·48	5·23	16·01*a*	2·28	Do. Blanzy.

(*a*) Oxygen and nitrogen.

The uses and localities of coal are too well known to need much notice, and belong more to geology than to mineralogy; indeed, as the composition of this substance cannot be expressed by a chemical formula, it has no just claim to be considered a simple mineral. (See Appendix, No. 2.)

The varieties containing most carbon give most heat, but are most difficult to kindle, and require a stronger draft of air. For gas, those coals are best in which the hydrogen bears a high proportion to the oxygen, and which are most free from sulphur and pyrites.

Varieties of coal:—

1. *Pitch* or *Caking Coal.* The quality of some coals, as it were, is to fuse and run together in the fire, or *cake*. This variety burns readily with a yellow flame, but requires much stirring up to allow ingress of air.

2. *Cherry Coal* resembles caking coal, but does not cake when burnt; it is easily frangible, hence in mining it there is much waste.

3. *Splint Coal* is a dry coal, with a slaty structure, tougher and harder than cherry coal.

4. *Slate Coal* has a thick slaty structure, and an uneven fracture, in the cross direction.

5. *Parrot*, or *Cannel Coal*, which is different in composition, and might rank as a sub-species, has a resinous glimmering lustre, and is very compact; it burns readily, with the production of a brilliant flame and much smoke, and was formerly employed by the miners for lights in their cottages; it is the variety from which the best gas is now extracted. It has a large conchoidal fracture, breaking into irregular cubical fragments; the best comes from near Wigan in Lancashire, Lesmahagow in Lanarkshire, and West Wemyss in Fife.

Analyses of Cannel Coal, by Dr. Heddle.

	Gas.	Carbon.	Ash.
Lesmahagow . .	53·74	43·34	2·92
Wemyss	52·12	36·58	11·30
Capeldrae . . .	55·00	38·18	6·82
Arniston . . .	58·30	40·68	1·02
Knightswood . .	48·88	52·56	·56
Marquis of Lothian's	55·20	43·93	·87
Oxenford . . .	47·20	51·76	1·04
Methil	44·80	38·78	16·42
Cowdenhillhead .	41·20	57·16	1·64
Largoward . . .	48·12	39·77	12·11
Lochgelly . . .	40·58	40·72	18·70
Wigan	50·18	46·42	3·40

The ash of cannel coals consists of silicate of alumina, with a considerable quantity of sulphate of lime—sometimes much oxide of iron.

6. *Flint Coal* contains much less bitumen, and resembles anthracite; the *flew coal* of Wedgebury in Staffordshire is of a similar nature; and the *crow coal* at Alston Moor in Cumberland, contains hardly any bitumen.

7. *Coking Coal* should be very free from sulphur; it is used for making coke, as at New Bridge, near Merthyr Tydvil in South Wales; at Newcastle, &c.

The annual weight of coal raised in the United Kingdom in 1855 was estimated at 65,000,000 tons, or, taking the ton of coal equal to about a cubic yard, more than nineteen square miles of a bed of coal, 3 feet thick. Of this amount 4,760,000 tons were exported, leaving the remainder for purposes of domestic and industrial consumption.

In 1851 it took 10,000,000 tons of coal to smelt the iron raised in this country, or about four tons of coal to produce one ton of iron. (See Appendix, No. 2.)

2 *b*. ANTHRACITE.—Non-bituminous Coal.

Amorphous, massive and disseminated; rarely in columnar forms, or fibrous and pulverulent. Fracture conchoidal. Opaque. Brilliant semi-metallic lustre; colour iron-black or greyish-black. Good conductor of electricity. Brittle. H. 2·0 to 2·5; Gr. 1·4 to 1·7. Burns with a weak flame, and does not cake. In the closed tube yields a little moisture, but no empyreumatic oil. Detonates with nitre. Composition C, carbon 85 to 99 per cent., with some oxygen and hydrogen, and traces of nitrogen. Also a mixture of silica, alumina, and peroxide of iron; sometimes a trace of bitumen. Analysis of an average specimen:—

Carbon	92·56
Hydrogen	3·33
Oxygen and nitrogen . . .	2·53
Ashes	1·58
	100·00

As the gaseous elements oxygen, nitrogen and hydrogen increase, this substance approaches nearer to coal.

Anthracite occurs in various parts of Great Britain and Ireland, but not in such quantity as in the United States of America. It occurs plentifully in Pembrokeshire, South Wales, where, as at the Bonville Court Collieries, a very pure crystalline variety is obtained, which ignites easily. At Bideford in Devon; Ayrshire in Scotland; in crystalline stalactites at Binney Craig, Linlithgow; at Kilkenny, &c. in Ireland.

Anthracite is commonly included under the general head of coal, and is chiefly used for smelting purposes; for its proper combustion it requires the blast, producing intense heat and little flame. (See Appendix, No. 2.)

Note.—Occurs in small irregular masses in pinkish dolomite, along with copper pyrites, at the copper-mines of Great Orme's Head, North Wales.

2 *c*. **LIGNITE.**—Brown Coal. Suterbrand. Jet.

Brown coal is more recent in its origin than that of the carboniferous era, and is more distinctly vegetable in its origin. Texture compact, woody or earthy. Often friable. Colour brown. Gr. 0·5 to 1·5. Burns easily with an empyreumatic smell. Contains more oxygen and hydrogen than common mineral coal. The constituents vary considerably in relative quantity; but on an average it may be taken at

Carbon	61·20
Hydrogen	5·00
Oxygen	24·78
Ashes	9·02
	100·00

This kind of coal is found pretty frequently in the Tertiary formations, less so in those of the Oolite and New Red Sandstone. It forms inferior fuel, burns with an unpleasant smell, and is seldom found in sufficient quantity or purity to be worked to advantage. (See Appendix, No. 2.)

Occurs at Bovey Tracey in Devonshire; in the Oolitic rocks of Yorkshire; near Waldron in Sussex; at Headon Hill in the Isle of Wight; Portree, Skye; at Gilmorton near Edinburgh; and at Brora in Sutherlandshire.

Ireland.—Co. Antrim, above the Giant's Causeway, between two beds of columnar basalt; and in Rathin Island. Co. Derry; in the parish of Ballynascreen, as at Craignashoke. Co. Tyrone; in the Tertiary clays of Clonoe and Washing Bay. It is pretty plentiful on the shores of Loch Neagh.

Jet is of a pitch-black colour, with resinous lustre and conchoidal fracture; often showing a tendency to divide into prismatic or columnar masses. It is much used for making ornaments. It is sectile and brittle. The best jet occurs in Yorkshire, as at Strafford and Roseberry, in veins between the rocks; the richest workings are about three miles south of

Whitby, on the direct road to Scarborough. The value of the jet manufactured at Whitby in 1855 was £20,000.

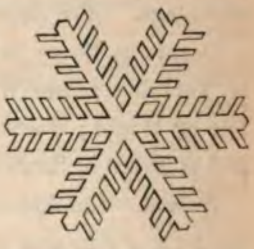
Lignite is applied more particularly to brown coal, having a woody and fibrous texture.

Order II. WATER.

3. ICE.

Rhombohedral. Usually in compound tabular hexagonal prisms, more rarely in rhombohedrons and hexagonal pyramids. When examined by polarized light, the basic plane exhibits with remarkable beauty the coloured rings and black cross, that plane being generally presented by the crust of ice formed upon water when not agitated while freezing. Fluid above 32° as *Water*. Pellucid. Colourless, in large masses greenish or bluish. H. 1·5; Gr. 0·95 to 0·97.

The crystals in the form of *Snow* are small, acicular, frequently presenting the form of hexagonal stars, feathery, dendritic, &c. See a paper upon the form of snow-crystals in 'Illustrated News' of 17th Feb. 1855, from the pen of Mr. Glaisher.



Contains—

$\dot{H}$	Oxygen . .	88·94
	Hydrogen. .	10·06

Pure water is tasteless and scentless; the purest which occurs in nature is atmospheric water—rain-water, snow-water. That of springs and rivers always contains carbonic acid, and is more or less impure from an admixture of salts.

Order III. RESIN.

4. AMBER.—Succinite, *Phillips*; Bernstein, *Haidinger*, *Hausmann*.

Amorphous. Fracture conchoidal and perfect. Transparent to translucent. Lustre waxy, resinous. Colour honey-yellow, reddish to brownish-yellow. Slightly brittle. When rubbed emits an agreeable odour, and acquires a negative electricity by friction. H. 2·0 to 2·5; Gr. 1·0 to 1·1. At 550° F. melts and is decomposed, yielding water and succinic acid, as well as an empyreumatic smell. Burns with a bright flame and peculiar odour, leaving a carbonaceous residue. Soluble in alcohol.

Contains, according to Schrötter,—

Carbon	78·82
Hydrogen . . .	10·23
Oxygen	10·95
	100·00

Formula, $C^{10}H^{8}O$=Carbon, 78·96; Hydrogen, 10·51; Oxygen, 10·53.

Occurs in rounded masses, and disseminated in the Tertiary brown-coal formations, in lignite, marl, and also on the sea-coasts; frequently contains insects and parts of plants. The vegetable origin of amber is now indisputable, being derived from the resins of extinct Coniferæ, among others the so-called *Pinites succinifer*.

Amber is occasionally found on the sea-coasts of Norfolk, Essex, Sussex, and Kent. In sand at Kensington near London; in the Isle of Wight. On the coast at Howth near Dublin, in small lumps of a rich yellow colour and highly transparent; in lignite at Craignashoke in Ulster; and in coal at Rathlin Island, Antrim.

5. COPALINE, *Hausmann*; Fossil Copal Resin, *Phillips*.

Amorphous. Fracture conchoidal. Semi-transparent to translucent. Lustre waxy. Yellow to yellowish-brown. Brittle. H. 2·5; Gr. 1·04. When heated emits a strong resinous and aromatic odour. Melts easily into a clear fluid. Burns with a bright yellow flame and much smoke, leaving very little residue. Slightly soluble in alcohol.

Analyses of a Highgate specimen by Johnston:—

Carbon . . .	85·68	85·41
Hydrogen. . .	11·48	11·79
Oxygen . . .	2·84	2·67
Ash	...	0·13
	100·00	100·00

Formula, $C^{40}H^{32}O$; with carbon, 85·96; hydrogen, 11·23; oxygen, 2·81.

Is found occasionally in the blue clay at Highgate Hill near London.

Another resin resembling the copaline in appearance has been described by Johnston, and found to consist of—

Carbon . . .	85·133
Hydrogen . .	10·853
Ashes. . . .	3·256
	99·242

or nearly C^4H^3; with carbon, 89·09; hydrogen, 10·91.

Colour pale yellow to deep red, with a pale green opalescence. Hard, but not brittle. Gr. 1·16 to 1·54. Does not melt at 400° F., but burns in the flame of a candle with an empyreumatic odour. Insoluble in water, and nearly so in alcohol and ether.

It occurs in the form of flattened drops or coatings on calcspar, on the walls of a trap-dyke at the old lead-mine in Northumberland, called Settling-stones.

6. MIDDLETONITE, *J. F. W. Johnston.* Phil. Mag. xii. 261.

In rounded masses, seldom larger than a pea. Lustre resinous. Colour reddish-brown by reflected light, deep red by transmitted; powder light-brown. Transparent in thin splinters. No taste or smell. Blackens on exposure. Brittle.

Gr. 1·6. Not altered at 400° F.; on a red cinder burns like resin. Boiled in alcohol or ether, the liquid becomes yellow, but dissolves little of the resin. Softens and melts in boiling nitric acid, with the emission of red fumes; a brown precipitate on cooling. Soluble in cold concentrated sulphuric acid.

Analysis by Johnston:—

Carbon	86·43
Hydrogen	8·01
Oxygen	5·56
	100·00

Formula, $C^{20}H^{10}+HO$; with carbon, 86·57; hydrogen, 7·77; oxygen, 5·66.

Occurs in thin seams and globules between layers of coal, about the middle of the main coal, or Haigh Moor seam, at the Middleton Collieries near Leeds; also at Newcastle.

7. RETINITE, *Haidinger*; Retinasphaltum, *Hatchett*, *Phillips*.

Occurs in roundish, or irregular lumps. Fracture conchoidal; opaque to translucent. Lustre resinous. Colour yellowish to yellowish-brown. Acquires resinous electricity by friction. Often flexible and elastic when first dug up; but afterwards loses this property. Has a dry earthy texture. H. 1·0 to 2·5; Gr. 1·135. Burns with the heat of a candle, with a bright flame and aromatic odour.

Analyses :—*a*, by Hatchett; *b*, by Johnston :—

	a.	*b.*
Resin soluble in alcohol	55·0	59·32
Bitumen	41·0	27·45
Earthy matter	3·0	13·23
	99·0	100·00

The insoluble matter, heated in a tube, blackens and gives off an empyreumatic odour; at a red heat it burns. The whole is soluble in alcohol except an unctuous residue, and the portion soluble is not similar to asphaltum.

Occurs with brown coal at Bovey in Devonshire.

8. SCLERETINITE, *J. W. Mallet.* Phil. Mag. vol. iv. p. 261.

Occurs massive in small drops or tears of round and ovoid forms, varying from the size of a pea to that of a hazel-nut. Sometimes two or three of these drops are stuck together. Colour, by reflected light, black; by transmitted, dark reddish-brown. Streak cinnamon-brown. Translucent on the edges. Lustre vitreo-resinous. Has a slight resinous odour when being pulverized. Fracture conchoidal. Brittle. H. 2·5; Gr. 1·136. Heated on platinum foil, it swells up, burns like pitch, with a disagreeable smell and smoky flame, leaving a coal rather difficult to burn, and finally a grey ash. In the glass tube yields a yellowish-brown oily product of a nauseous empyreumatic odour. Insoluble in dilute acids, caustic alkalies, or ether

Analyses; both by Mallet :—

Carbon	76·74	77·15
Hydrogen	8·86	9·05
Oxygen	10·72	10·12
Ash	3·68	3·68
	100·00	100·00

Formula, $C^{10}H^{7}O$; with carbon, 80·32; hydrogen, 9·18; oxygen, 10·50. Taking the number of atoms of carbon at 40, which exist in so many resins, the formula becomes $C^{40}H^{28}O^{4}$; being nearly that for amber, viz. $C^{40}H^{32}O^{4}$.

From the coal-measures near Wigan in Lancashire.

9. BUTYRITE.—Butyrite, *Glocker*; Bog Butter, *Hartite* (in part).

May be only a variety of Guyaquillite or Hartite.

It melts at 124° F., and is easily soluble in alcohol; consists, according to Williamson, of,—

Carbon	73·33
Hydrogen	12·46
Oxygen	13·71
	100·00

Formula, $C^{33}H^{32}O^{3}+HO$; with carbon, 75·65; hydrogen, 12·35; oxygen, 12·00.

Occurs in some of the Irish swamps.

10. BITUMEN, *Haidinger*; Naphtha, *Phillips*; Petroleum, Mineral Pitch, Mineral Oil; Elaterite, *Hausmann*.

Bitumen includes several distinct species; the principal ones are Naphtha, Petroleum, Elaterite, and Asphaltum.

a. NAPHTHA. Includes the fluid varieties. Liquid and transparent when pure. Colourless, yellow-brown. Unctuous to the touch. Smell aromatic and bituminous. Boils at a temperature below 100° C. Burns with a bituminous smell. Soluble in pure alcohol. By exposure to the air naphtha becomes thick, and at last solid. Usually combined in nature with asphaltum.

Analysis by Dumas:—

Carbon	86·40
Hydrogen	12·70
	99·10

Formula, $C^{6}H^{5}$; with carbon, 86·58; hydrogen, 13·42.

b. PETROLEUM. At the usual temperature rather thicker than common tar; has a bituminous odour; is soluble in ether and alcohol; burns with a thick black smoke; colour brown, black, reddish-brown; probably a mixture of naphtha and asphaltum.

Analysis of a specimen from Alsace in France, by Boussingault:—

Carbon	88·7
Hydrogen	12·6
	101·3

LOCALITIES.—Cornwall. At Wheals Unity and Jewel, in Gwennap, and at Carharrack, St. Day; at Chudleigh in Devon; at Mostyn in Flint; at Colebrook Dale in Staffordshire; at Madeley, fifteen miles S.W. of Salop, at Pitchford, 6¼ miles south of Salop, and at Penalay lead-mine, Bishop's Castle,—all in Shropshire; in limestone at Hotwells, near Bristol in Somersetshire; at Ormskirk in Lancashire; at the Odin mine, near Castleton in Derbyshire; and at St. Catherine's Well near Edinburgh.

c. ELATERITE, or elastic bitumen; occurs in compact, reniform or fungoid masses, elastic and flexible, like caoutchouc. Soft, sometimes gets harder on exposure. Translucent on edges. Colour brown, olive-brown, black.

Analysis by Johnston of a specimen from Derbyshire:—

Carbon	85·47
Hydrogen	13·28
	98·75

Occurs plentifully at the great Odin mine, at Castleton in Derbyshire, with calc-spar, fluor, and barytes, in secondary limestone; occasionally near Edinburgh, as at St. Bernard's Well; with calcite, formerly at the Chapel quarries in Fifeshire.

d. ASPHALTUM, bitumen, or mineral pitch, is solid, with a conchoidal fracture; opaque; lustre resinous, black, inclining to brown. H. 2·0; Gr. 1·15. Melts at 100° C; burns easily with a smoky flame, leaving a small residue of ashes; soluble in ether, except a small remainder.

Analysis of a specimen from Auvergne, by Ebelmen, *a*; from Peru, by Boussingault, *b*:—

	a.	*b.*
Carbon	76·13	88·63
Hydrogen	9·41	9·69
Oxygen	10·34	1·68
Nitrogen	2·32	
Ash	1·80	...
	100·00	100·00

Occurs compact, disseminated, and stalactitic.

LOCALITIES.—Cornwall; Poldice mine, coating quartz, and in the copper veins at a considerable depth; at Carharrack, St. Day; South Wheal Towan, St. Agnes; at Great Wheal Crofty and Wheal Rosekean, both near Camborne. Derbyshire; at the Odin mine, and Tray Cliff near Castleton, investing calc-spar, fluor, and also fossil shells, and near Matlock. Shropshire; at Haughmond Hill. Somersetshire; at Hotwells near Bristol, in limestone.

With calcite at Hurlet near Glasgow; occasionally in freestone at Binney quarries near Edinburgh; in carboniferous limestone near Burntisland, Fife; in ironstone nodules in East Lothian. In the sandstone of Caithness; and generally throughout the Orkneys.

Note.—Wilson says of the Binney quarry freestone,—"It has been for many years used in Edinburgh for building-stone. It has mixed through it a quantity of native bitumen, which acts as a native varnish to the stone, defending it from the action of the atmosphere. It is so abundant there that the workmen make candles of it, and use it for domestic purposes. It yields, on distillation, *paraffine*, and a liquid hydrocarbon resembling naphtha."

c. KIMMERIDGE SHALE. Is a combination of bituminous matter with clay; colour brown, and without lustre. Gr. 1·32.

Effervesces slightly in acids, and burns readily with a yellowish and smoky flame. It is quite a local deposit, and probably the result of the decomposition of animal remains.

Occurs at Kimmeridge in Dorset, in the cliffs; and in the Isle of Purbeck.

Analysis by Heddle :—

Combustible gases	18·466
Carbon	·337
Ash	81·137

The ash consisted of carbonate of lime, phosphate of lime, and a little silicate of alumina.

Bituminous shales would seem to be clays impregnated with coaly rather than bituminous matter; they run into the cannel coals.

Analyses by Heddle :—

	Gas.	Carbon.	Ash.
Mussleburgh	30·02	25·89	44·09
Dalkeith	35·56	25·94	38·50
Wemyss	47·96	31·04	21·00
Clockmydron	25·87	22·11	52·02

The ash consisted of silicate of alumina.

11. **TORBANITE.**—Bitumenite, *Traill.* Argillo-bitumen. Argilole. Boghead mineral. Boghead coal.

Amorphous. Fracture subconchoidal. Tough. Translucent on the edges, transmitting light of a red colour. No lustre. Colour clove-brown. Streak yellow, without lustre. Sectile. Takes fire readily, burning with an empyreumatic odour, a very brilliant lively flame, and an enormous quantity of dense smoke, leaving a white friable mass identical in form with the specimen before combustion. H. 2·25; Gr. 1·18 Heddle, 1·17 Chapman.

Analyses: *a*, Anderson; *b*, Hofmann; *c*, Stenhouse; *d*, Fife:

	a.	*b.*	*c.*	*d.*
Carbon	64·02	65·66	65·5	60·25
Hydrogen	8·90	8·90	9·	8·8
Nitrogen	·55	...	...	1·5
Sulphur	·5	...	...	·13
Oxygen	5·66	...	...	3·6
Ash	20·32	19·10	19·5	25·6
	99·95	93·66	94·0	99·88

Occurs near Bathgate in Linlithgowshire; as at Torbane, Boghead, Bathvale and Torbane Hill, in a stratum 20 to 24 inches in thickness, and seems to have resulted from the partial decomposition of a substratum of coal by the heat of underlying trap, the volatile matters having been retained in what has evidently been a bed of shale: the under coal is little better than anthracite.

This valuable mineral is employed for two purposes:—first, for the extraction of lubricating oils, paraffine oil, paraffine and naphtha, one ton of the mineral yielding about £6 worth of these substances; secondly, for the extraction of a gas which differs from the gas obtained from cannel coal in containing 30 instead of 6 or 8 per cent. of olefiant gas: the illuminating power of this gas is as 8·7 to 3 of the best gas produced from cannel coal; one ton of the mineral contains 15,800 feet of this rich gas, and produces 18,000 to 20,000 feet of an ordinary gas by the hydrocarbon process, while 10,000 feet would be a fair yield per ton for Wigan, Lesmahagow, Wemyss, or the best cannel coals.

The ash left after the extraction of the above products has been found to be the best basis for colours, in fresco, &c.

Analyses: *a*, Anderson; *b*, Wilson; *c*, Stenhouse; *d*, Heddle; *e*, Hofmann:—

	a.	*b.*	*c.*	*d.*	*e.*
Silica. . . .	56·09	55·15	58·51	55·50	56·7
Alumina. . .	40·04	39·18	34·75	38·85	36·2
Peroxide of iron	3·24	3·90	7·	2·93	3·2
Lime	·34	·55	...	1·04	1·3
Magnesia . .	·46	...	...	·20	·4
Potash . . .	...	...	·84	·65	1·2
Soda	...	...	·5	·5	1·
Carbonic acid .	...	1·15	...	...	...
	100·17	99·93	101·60	99·67	100·0

Formula, $\dddot{Al}^2\dddot{Si}^3$; with silica, 57·42; alumina, 42·58.

12. OZOCERITE.—Erdwachs, *Rammelsberg.*

Resembling a resinous wax. Structure often foliated. Colour brown or brownish-yellow by transmitted light, leek-green by reflected light. Odour aromatic. Brittle. Gr. 0·95. Fuses at 60° C., boils at 121° C. according to Johnston's experiments on the Urpeth variety; the foreign variety from Moldavia is not quite so sensible to heat. Distils without apparent decomposition. Not acted on by acids. Dissolves more or less in ether, that from Urpeth to the extent of four-fifths.

Analyses: *a*, from Moldavia, by Schrötter; *b*, from Urpeth, by Johnston:—

	a.	*b.*
Hydrogen. . .	13·79	14·06
Carbon . . .	86·20	86·80
	99·99	100·86

Formula, $C\bar{H}$; with carbon, 85·97; hydrogen, 14·03.

Occurs at the Urpeth Colliery, near Newcastle-on-Tyne. Also, as noticed by Krantz and Heddle, at Uphall in Linlithgowshire.

13. HATCHETINE, *Conybeare, Phillips.* Mineral Tallow.

Translucent, opaque. Lustre slightly pearly, nacreous. Resembles wax or spermaceti in consistency. Colour white, yellowish-green, grey, but becomes darker and more opaque on exposure. Feel greasy. H. 1·0; Gr. 0·60, after fusion, 0·98. Melts (from Loch Fyne at 47° C., from Merthyr-Tydvil at 76°·6 C.) into a transparent colourless liquid, which becomes opaque and white on cooling. Emits when heated a bituminous odour. Heated cautiously it distils over without change; dissolves sparingly in hot alcohol, precipitating again on cooling. Partially soluble in warm ether, and on cooling, the solution coagulates into a mass of pearly fibres.

Composition, according to Johnston, of Hatchetine from Merthyr-Tydvil:—

Carbon	85·91
Hydrogen	14·62
	100·53

Formula, $\mathrm{CĦ}$, or the same as Ozocerite.

Occurs in the crevices of Septaria and the ironstones of the coal-formation at Ebbw Vale near Merthyr-Tydvil, in Glamorganshire, in masses resembling wax or train-oil; also near Loch Fyne near Inverary, in Argyleshire.

Order IV. SULPHUR.

14. SULPHUR, *Phillips*; Soufre, *Hauy*; Schwefel, *Mohs*.

Prismatic; primary form a four-sided pyramid, with a rhombic base. Occurs crystallized, massive, disseminated, and investing other minerals. Cleavage imperfect; fracture conchoidal, uneven. Lustre shining and resinous; transparent, translucent. Colour sulphur-yellow, passing into red, brown, grey. Very brittle, but rather sectile. H. 1·5 to 2·0; Gr. 2·05. Burns readily with a lambent blue flame in the flame of a candle, emitting at the same time strong pungent fumes of sulphurous acid, and fuses into a brown liquid. Burns of itself like a torch. Acquires resinous electricity by friction.

Composition: S, more or less pure.

Sulphur occurs principally in the vicinity of active and extinct volcanoes; also sometimes with gypsum, celestine, and rock-salt.

Localities.—It is a rare mineral in its native state in Great Britain. Cornwall: it has been observed by Mr. Garby at Poldice mine in Gwennap, and at Nangiles mine, Kea, in cavities of iron pyrites.

In small, perfect, highly modified crystals in galena near Wirksworth and Cromford at Bole Hill, Derbyshire; and similarly on the large rough octahedral crystals of galena formerly found at Dufton in Westmoreland; occasionally with gypsum at Alston in Cumberland.

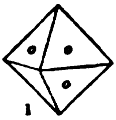
Ireland. Interspersed with calc-spar at Brooklodge, co. Galway; near Glan, co. Cavanagh. In compact mountain limestone at Castle Cara, co. Mayo.

Sulphur in the United Kingdom is produced from *mundic*, or iron pyrites; of which there are now annually exported from Ireland nearly 60,000 tons, principally shipped to Wales, where the sulphur is extracted.

Order V. FLUORIDES.

15. **FLUOR.**—Fluor, *Brooke* and *Miller*, *Phillips*; Chaux fluatée, *Hauy*; Fluss, *Hausmann*, *Haidinger*; Fluss-spath, *Naumann*; Liparit, *v. Kobell.*

Cubic. Primary form, octahedron. Cleavage very perfect parallel to *o*; less so to *d* and *a*. *a* smooth, sometimes striated parallel to intersection with *t* or *f*; *f*, *o* frequently rough. Twins. Twin face *o*. Fracture conchoidal, more or less perfect, but not easy to obtain. Transparent, translucent, opaque. Lustre vitreous. Colourless and transparent occasionally, but usually occurs coloured in varied and rich tints of yellow, green, blue, purple, violet. Not unfrequently two colours, sometimes more, are disposed in layers parallel to the faces of some of the simple forms, and a crystal of one colour occurs imbedded in the interior of a crystal of another colour, as at Beeralston, as cited



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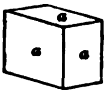

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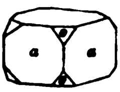

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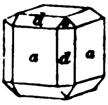

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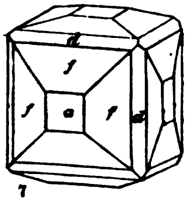

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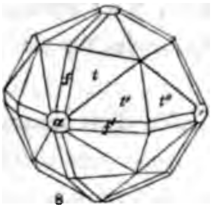

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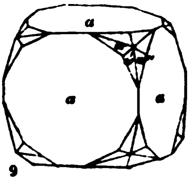

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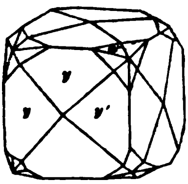

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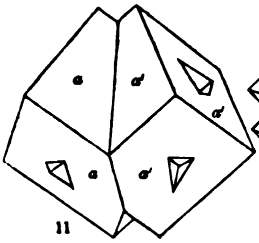

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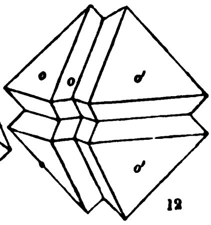

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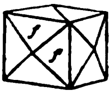

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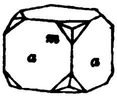

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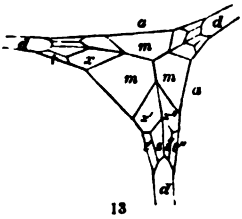

a
d
d
m
x
m
m
a
x'
d

13

o o	109°	28′	*m a*	154°	56′	*t t′*	162	15	
a a	90	00	*w w′*	167	47	*t′ t″*	144	03	
o a	125	16	*w w″*	136	47	*t a*	150	48	
d d	120	00	*w a*	155	42	*s a*	146	—	
d a	135	00	*w o*	145	46	*s s″*	159	—	
f a	161	34	*x x′*	166	57	*y y*	177	—	about.
f f	126	52 over *a*,	*x′ x″*	140	09	*y y′*	175	30	
m m	120	31	*x a*	152	04	*f f′*	154	09	

below. The colours of fluor are sometimes different according as they are seen by reflected or by transmitted light. One variety is green by transmitted light and blue by reflected light; another grey, almost colourless, by transmitted light, and purple by reflected light. Brittle. Streak white. H. 4; Gr. 3·1 to 3·2; according to Brooke and Miller the specific gravity of some varieties is as low as 3·017. Phosphoresces when heated.

British forms. *o*; *a*; *oa*; *ad*; *ado*; *at*; *aw*; *am*; *af*; *afo*; *afon*; *aft*; *afd*; *aet*; *yw*; *awo*; *admxt*; *admxts*. According to Miller, the angles for the obtuse planes *y* vary several degrees.

Before the blowpipe often decrepitates with violence, phosphoresces and fuses in thin splinters to an opaque mass, tinging the flame red; this mass is infusible in a stronger heat, and its subsequent behaviour agrees with that of lime; with selenite it fuses to a clear bead which loses its transparency on cooling; in powder fused in the tube with salt of phosphorus which has been previously melted, it gives off hydrofluoric acid. Completely decomposed by concentrated sulphuric acid with evolution of the above acid; not readily dissolved in hydrochloric or nitric acid.

	Fluorine . . .	47·73
	Calcium . . .	52·27
CaFl.		100·00

Occurs usually in attached crystals, also fibrous, granular, earthy and compact. The crystals sometimes contain grains and crystals of quartz, drops of fluid, and other foreign matter. Chlorophane is a name given to those varieties which, when exposed to a moderate heat, phosphoresce with a peculiar bright-green colour. It is said not to decrepitate when heated.

LOCALITIES.—*England.* Cornwall. This mineral has been met with in remarkable perfection at Wheal Mary Ann, Menheniot, in fine blue beveled cubes. Near St. Agnes, formerly, of a rich lilac, translucent, of the forms of figures 5 and 7; and at the same locality in octahedrons built up of minute cubes of a purple colour. At Wheal Devonshire near St. Agnes. Fine cubes and octahedrons at South Caradon near Liskeard. At St. Michael's Mount. At Wheal Gorland and Wheal Unity. In large purple translucent crystals, formerly, at Wheal Trevannance. At Wheal Maudlin near Lostwithiel, in large semi-transparent octahedrons, with chlorite and chalcedony. At Wheal Trelawney near Liskeard, recently, in deep blue beveled cubes. In colourless elongated cubes at South Caradon, Liskeard.

Fibrous, earthy and compact at Trahane, Menheniot; and at West Grambler near St. Day. Figures 8 and 10 represent Cornish forms.

Cumberland. In fine, yellow, transparent crystals, recently, at Cleaton Moor. It is common in the neighbourhood of Alston: the prevailing colours at this locality are lilac and green. In the latter, not unfrequently there are contained drops of a fluid. The liquid occurs most frequently in those cubes the faces of which have a dull, almost greasy look, and especially in those whose edges are widely beveled. These drops are also met with sometimes in the lilac and purple varieties. Grey cubes superimposed and curiously elongated are also found at Alston.

At this locality crystals occur whose colour is different according as it is seen by reflected or by transmitted light. The variety found here is green by transmitted light and blue by reflected light. The ordinary form of crystal at Alston Moor is the cube, but the forms given in figures 3, 6, 9, 10, and 11 are likewise met with. Figure 13 shows the modifications on the solid angles of an Alston crystal in Mr. Greg's Collection.

Earthy fluor, grey and white, occurs also at that locality.

Derbyshire. Compact and granular, abundant. The finest specimens for ornamental purposes occur at Tray Cliff near Castleton, where it is known by the name of *Blue-john.* The fine rich purple or red colour of the articles wrought in this brittle material is not the natural hue of the stone, but is brought out by exposing it to heat.

Devonshire. At Beeralston several interesting varieties as to form and colour are to be met with. Cubic forms are prevalent, as in figures 2, 4, 6, 7, and 9. The finest crystals are either colourless or of a pale sea-green internally, and upon the surface or only the edges, of a rich smalt-blue; or a contrary disposition of colour is observable, the central portion of the crystal being coloured, and the parts towards the surface, or sometimes only the edges, colourless. In octahedrons, figures 1 and 12, of a pale green, and translucent not uncommonly, though more generally white and opaque, disposed on hornstone; it is plentiful here. It is this variety which so frequently occurs in pseudomorphs of hornstone, or capped with quartz. At this locality it is also met with fibrous and compact, of a pale green. At East Tamar mines.

Durham. At Weardale, Allendale, Allenhead, Nenthead. At Weardale sometimes crystals occur, the colour of which varies as they are examined by transmitted or by reflected light; grey or colourless by one and purple by the other.

Lancashire. Ulverstone, in colourless crystals with limnite.

Somersetshire. At Clifton in crystals, scarce.

Wales.—In fine cubes $2\frac{1}{2}$ inches square, of a dark amethyst colour, at Moel-y-Cria, North Wales. At Halkin Mountain near Holywell, Flint.

Scotland.—Aberdeenshire; in granite, at Balater House, parish of Glenmuick, of a blue colour. Banffshire, at Keith.

Dumbartonshire; in perfect cubes, both purple and deep green, with calcite, in cavities in greenstone, at Dumbarton.

Renfrewshire; at Gourock near Greenock, in cavities in the trap-rock, in purple and in green octahedrons and cubes.

Sutherlandshire, occasionally, in gneiss.

Shetlands; in Papastour, with chalcedony and chlorite, in cavities in amygdaloid.

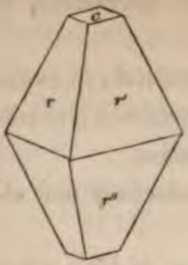
Ireland.—Very fine at several mines in Clare county. Galway; in fine octahedral crystals, lately, at Inveran lead and copper mines, with blende and calamine; massive at Rahoon. County of Dublin; at Golden Bridge, in cubic crystals. In Donegal; near Rathmullen, in limestone. Tyrone; near Omagh, lining the cavities of fossil shells, occasionally. Antrim; small green octahedrons in the granite of Slieve Carne. Morne Mountains. Dalkey Island, Dublin Bay, in cavities in granite. Wicklow; at the Glendalough lead-mines, plentifully, both crystallized and massive, of a pale violet-blue colour.

Fluor is employed not only for the production of hydrofluoric acid for the purpose of etching on glass, but is likewise used as a flux. One mine in Devonshire sold no less than 400 tons for the use of metallurgists in 1853.

16. **FLUELLITE.**—Fluellite of English and French mineralogists. Fluellit of German authors.

Prismatic. Primary form a right rhombic prism of 105°, whose base is to its height in the proportion of 1 to 3. White, translucent to transparent. Lustre vitreous. H. 3.

Contains, according to Wollaston, fluorine and aluminium. It was first noticed by Levy, and is an extremely scarce mineral; a few specimens were obtained about forty years ago, and none again met with until four or five years since, when Mr. Richard Talling, an active and intelligent dealer in minerals at Lostwithiel, succeeded in obtaining a few specimens at the old



$r\,c$	108° 00'
$r\,r'$	109 04
$r'\,r''$	144 00

Combinations: r; $c\,r$.

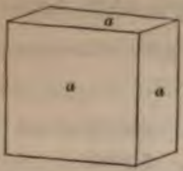
locality, Stenna Gwyn, near St. Austell in Cornwall, in minute crystals associated with uranite and acicular Wavellite on a grey quartz-rock; it sometimes forms a crust of minute crystals in clefts of the quartz-rock itself. For the last four summers (it is only during dry weather that the spot is accessible) Mr. Talling has in vain endeavoured to procure a single fresh specimen, but as he intends renewing his search, it is to be hoped that his perseverance will again be rewarded. In the meanwhile it may be of service to him to mention, for the information of collectors, that he still has in his possession two or three specimens of this very rare species at their disposal.

Order VI. CHLORINE.

17. COMMON SALT.—Rock-salt. Chloride of Sodium.

Cubic. Cleavage perfect, parallel to the faces of the cube. Massive, granular. Fracture conchoidal. Transparent to translucent. Colourless, white, grey, blue, often stained brown or yellow. Taste saline; very soluble; slightly deliquescent. Thin plates when polished readily transmit rays of heat, in this respect the reverse of glass. Brittle. H. 2·5; Gr. 2·2.

In the matrass decrepitates and yields water. Imparts a yellow colour to the flame. Dissolves in three parts of water.



$a : a = 90° \cdot 00'$.

Analysis of rock-salt from Cheshire, by Henry:—

Chloride of sodium	98·32
Sulphate of lime	0·65
Chloride of magnesium . .	0·02
Chloride of calcium	0·01
Insoluble matter	1·00
	100·00

Formula, $NaCl$; with chlorine, 60·34; sodium, 39·66.

Occurs fibrous, stalactitic, crystallized, granular, also pseudomorphous, and dissolved, as in the sea or brine-springs; in Cheshire has also been observed in orbicular masses, with concentric coats.

Localities.—Cheshire; at Northwich, Nantwich, Middlewich and Winsford; in Co. Durham; in Staffordshire at Shirleywich; Gloucestershire, at Droitwich; occasionally in Worcestershire.

Ireland.—At Carrickfergus, co. Antrim, rock-salt occurs in beds 5 feet thick.

Pseudo-impressions of crystals of salt are of common occurrence in the New Red Sandstone and clay-shales of Cheshire.

For some particulars respecting the manufacture and statistics of salt, see Appendix, No. 3.

18. SAL-AMMONIAC.—Muriate of Ammonia.

Cubic. Usually stalactitic, pulverulent, or incrusting. Colour white, yellow, grey. Fracture and lustre vitreous. Translucent, opaque. Pungent and saline to the taste. H. 1·5 to 2·0; Gr. 1·53. Soluble in three times its weight of water; completely volatile at a high temperature, rising in white fumes, and emitting when triturated with lime a pungent ammoniacal odour.

When pure, contains—

	Chlorine . . .	66·11
	Ammonium . .	33·89
NH^4Cl.		100·00

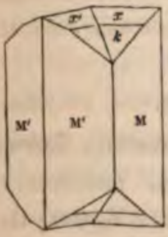
Usually occurs in the neighbourhood of volcanoes, but in this country occasionally in the vicinity of ignited coal-seams, as near Newcastle in Northumberland, and at Bradley in Staffordshire; also at Hurlet near Paisley, in Scotland.

It is used in dyeing and in medicine, but for these purposes is prepared chemically.

Order VII. CARBONATES.

19. ARRAGONITE.—Arragonite, *Phillips, Hauy.* Arragonit of German mineralogists.

Prismatic. Primary form a right rhombic prism of 116° 10′. Has one very distinct cleavage. Fracture conchoidal to uneven. Lustre vitreous, inclining to resinous on surface of fracture. Transparent to translucent. Colourless, white, often yellowish-white to wine-yellow, reddish-white to tile-red, also pale-green, violet, grey. Twin crystals very common. Brittle. H. 3·5 to 4; Gr. 2·9 to 3, in aggregations as low sometimes as 2·7.



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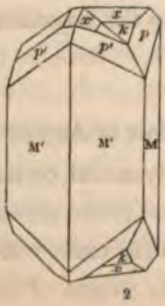

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M′M′	116°	10′	
M′*a*	121	52	
k k	108	26	over summit.
x x	140	22	
p′ p′	129	32	

The forms M *k*, M *k p*, M *k x*, M *k x s* occur at Cleator Moor.

In the matrass swells and falls to a coarse powder, fragments of which when heated in the forceps impart a red tinge to the flame should strontia be present. On charcoal becomes caustic. Easily soluble, with effervescence, in nitric or hydrochloric acid.

Analyses of Arragonite: *a*, from Herrengrund in Hungary, by Delesse; *b*, from same locality, by Nentwich; *c*, from Papenberg in Hessia, by Stieren:—

	a.	*b.*	*c.*
Carbonate of lime	99·87	98·62	97·39
Carbonate of strontia . .	...	0·99	2·22
Peroxide of iron	...	0·11	...
Water	·13	0·17	0·39
	100·00	99·89	100·00

$\dot{\text{Ca}}\ddot{\text{C}}$; carbonic acid, 43·71; lime, 56·29.

Usually contains a small quantity of carbonate of strontia varying in amount from ½ to 4 per cent. The fibrous variety called ***satin-spar*** from Dufton in Cumberland, contains 4·25 per cent. of carbonate of manganese. All the varieties appear to contain a small quantity of water, hardly ever, however, exceeding ·4 per cent.

In attached crystals, also very frequently in dendritic and coralloid shapes, having a drusy surface, globular, fibrous, and in compact masses.

LOCALITIES.—*England.* Cornwall, in globular concretions, on quartz and siderite, near St. Just. Crystallized and coralloid at Levant mine, St. Erth; at Wheal Edward, Calstock; and at Mawnan Cliffs near Falmouth.

Devonshire, at Buckfastleigh; spicular, very fine, at Ilfracombe; at Torbay in aggregated acicular crystals with a fibrous structure.

Dorsetshire; at Osmanton Mill, five miles east of Weymouth, on the shore.

Derbyshire; of a green colour, Cumberland Cavern near Matlock.

Cumberland; at Cleator Moor, in very fine radiating crystals, terminated as in fig. 2, of a reddish-brown colour. At Alston, in limestone, in beautiful, delicate transparent crystals, with galena and quartz. Capital specimens have been met with recently at Nent Force near Alston. In very fine snow-white coralloidal and stalactitic shapes at Dufton, formerly. The fibrous variety termed satin-spar occurs in a cliff of decomposing shale at Alston; it has sometimes a rose tinge; also at Dufton Fell.

Durham; at Lunton Hill old coal-pit, six miles south-west of Cockfield. There are several other good localities in the North of England, as, for instance, at Nenthead, where it occurs of a yellow colour, coating fluor; also at West Allendale.

In Somerset; in a cave at Merridge, Quantock Hills; in very fine coralloid forms at Halwell Cavern, Froomfield near Taunton.

Scotland.—At Leadhills, in long radiating transparent crystals, terminated as in fig. 1; also stalactites of snowy whiteness. In silky fibrous masses, and in radiated and concentric stalactitic shapes in Dirk Hatterick's Cave in Galloway. In veins traversing greenstone at Seafield in Fifeshire. At Portsoy in Banffshire.

Shetlands. At Swinaness in Unst, in small crystals, and likewise fibrous, associated with Brucite. On calcite and chromite, Haroldswick.

Orkneys. Fibrous, the variety called satin-spar, a vein two inches thick in the Island of Pharay, and at Rackwick in Hoy.

Ireland.—Antrim; of a fine oil-green colour, radiated; at Ballintoy, associated with antrimolite. Occasionally at Portrush, and at the Giant's Causeway.

Derry; in stellated groups in greenstone fissures at Dungiven and Benevanagh.

Downshire; at Glass Drummond, crystallized and massive.

Kerry; fine acicular, of a green colour, at New Copper Mines, Kenmare, twelve miles south of Killarney.

It occurs likewise at Macgilligan, in radiated crystalline masses of a dark colour; and in similar masses, of a rose colour, in a soft wacke at Down Hill.

The "Flos ferri" variety occurs at the Black Path, Down Hill.

In Glocker's 'Mineralogische Jahreshefte' there are mentioned some interesting experiments on the deposition of crystalline Arragonite from lime-water, holding sugar in solution.

20. CALCITE.—Calcite, *Shepard*, *Brooke* and *Miller*; Carbonate of Lime, *Phillips*; Chaux carbonatée, *Hauy*; Kalk, *Hausmann*; Kalkspath, *Naumann*; Calcit, *Haidinger*, *v. Kobell.*

Rhombohedral. Cleavage parallel to P, very perfect, and easily obtained; sometimes traces parallel to *o*, *c* and *r*. Twins; twin face *o*, the axes of the rhombohedrons parallel: this is the commonest form of twinned crystals, and their appearance (which is due to the juxtaposition of two individuals, of which only one-half is present, upper and lower) is usually very symmetrical; figures 23, 24, and 27. Twin face *g*, the axes making an angle with each other of 127° 30′: this composition is frequently repeated, many times the inner individuals being very much shortened; the planes of union parallel to *g* may be taken for planes of cleavage. Twin face P, the axes forming an angle of 90° 46′. Twin face sometimes *f*, the axes of the rhombohedrons then meeting under an angle of 53° 46′.

The faces *o* are generally rough; *g* striated parallel to their intersection with P; *c* sometimes dull. Fracture conchoidal, but, owing to the facility of cleavage, only seldom observable.

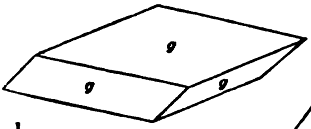
Transparent, translucent. Lustre generally vitreous; but on some planes, especially on those that are curved, resinous; *o* pearly sometimes, but frequently dull. Remarkable for its double refraction. Naumann, in his 'Mineralogy,' mentions an interesting discovery by Mitscherlich, to the effect that in minerals belonging to the rhombohedral system the angle between the principal cleavages is opened out on a specimen being raised from the ordinary temperature of the air to that of boiling water. In the case of calcite, this takes place to the extent of 8′·6. Colourless; white; accidentally yellow, grey, brown, red, lilac, green, black. Streak white. Brittle. Acquires vitreous electricity by pressure. H. 3: the hardness of prism-planes is, however, as Frankenheim has shown, superior to that of the planes of cleavage, the comparative softness of which was indeed noticed by Huyghens. Gr. 2·6 to 2·8; that of pure transparent calcite is 2·72.

The angle of the primary rhombohedron P, varies from 105° 03′ to 105° 18′; the commonest being 105° 08′.

Infusible before the blowpipe; becomes caustic and shines with remarkable brightness; behaviour, that of lime. Moistened with hydrochloric acid effervesces very freely, and is readily soluble in nitric or hydrochloric acids, without being reduced to powder on the application of heat. According to v. Zehmen, when calcite, in very fine powder, is exposed to a red heat on platina-foil over a spirit-lamp, it forms a somewhat coherent mass, adhering to some extent to the foil.

Analyses of calcite: *a*, from Iceland, by Phillips; *b*, from Andreasberg, by Hochstetter:—

	a.	*b.*
Carbonic acid	44·0	42·20
Lime	55·0	54·40
Protoxide of iron	...	1·55
Silica	...	1·85
	99·0	100·00



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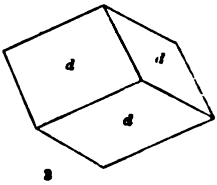

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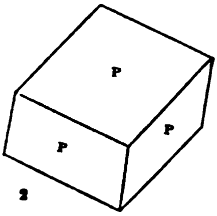

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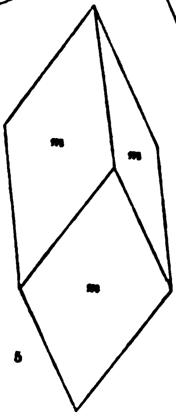

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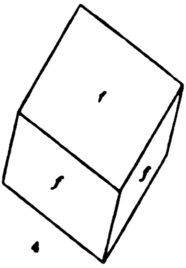

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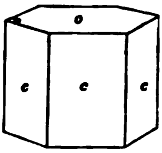

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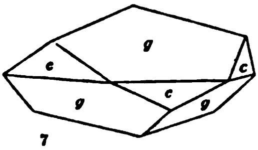

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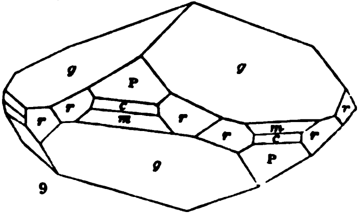
g
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m
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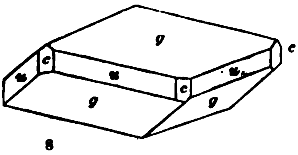
m
c
r
r
g
P

9



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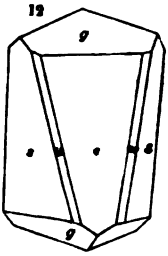

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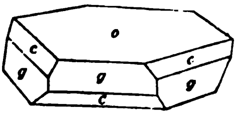

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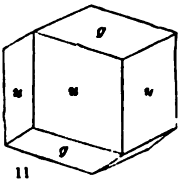


11

g g	134° 57′	principal rhombohedrons.
P P	105 05	
d d	92 08	
f f	78 51	

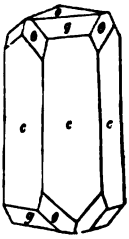
$\dot{\mathrm{C}}\mathrm{a}\ddot{\mathrm{C}}$, in the purest varieties; carbonic acid 44, and 56 lime; but in most varieties there are slight admixtures of magnesia, or protoxide of iron; in others, carbonate of manganese and oxide of zinc are present, replacing a corresponding portion of the lime. These admixtures cannot but exercise a certain influence on the measurements, the specific gravity, and other properties, so that slight variations are naturally to be looked for.

Occurs in attached and imbedded crystals in limestone cavities and veins, in trap and greenstone rocks, in fact, in rocks of every age; stalactitic and massive. Also in fossil shells. In this country it is found most frequently accompanying fluor, galena, quartz, and pyrites.

The forms in which calcite crystallizes are exceedingly numerous, and in no country are finer or more varied modifications of form to be met with than in the United Kingdom. The leading forms may, however, be classed under three heads: rhombohedral, prismatic, and pyramidal, or metastatic. The rhombohedrons, of which no less than 41 have been already observed, are divided into obtuse and acute. As many as 85 distinct scalenohedrons have been noticed; but only 7 hexagonal pyramids are known. In the whole, as many as 750 different combinations are known. The combinations between the three classes of crystals are indeed endless; but on most of them may be generally observed some of the faces P, *c*, *f*, *g*, *m*, *o*, *r*, and *t*, which serve as guides in determining the position of the crystals.

The chief localities in England for fine specimens of calcite occur in Cornwall, Devonshire, and Derbyshire; in Wales, in Flintshire, and formerly at Castell Coc, Glamorganshire; in Scotland, at Strontian in Argyleshire; in Ireland, at Kingston Cave near Cahir, Co. Clare.

The localities of calcite are so numerous, that only the most remarkable can be cited here.



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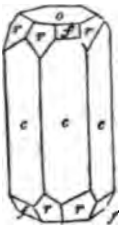
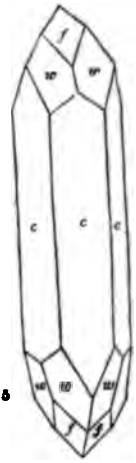
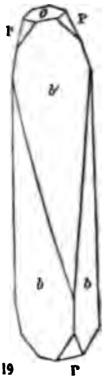

o
r
r
f
r
c
c
c
r
r
f

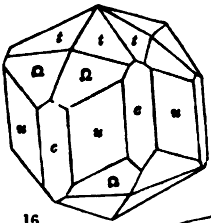
14


f
w
w
c
c
c
w
w
w
f
f

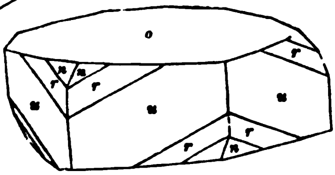
15



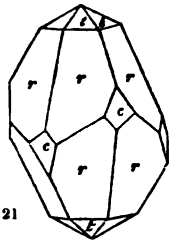
19


t
t
t
Ω
Ω
c
u
u
c
u
Ω

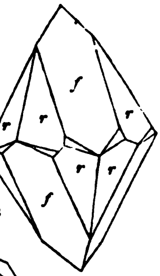
16


o
r
n
m
r
r
u
u
u
r
r
n

17

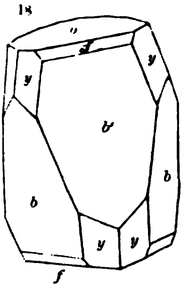

t
t
r
r
r
c
c
r
r
t

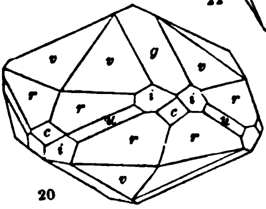
21



22

18


o
d
y
y
b'
b
b
y
y
f


v
v
g
v
r
r
i
c
i
r
c
i
u
r
r
u
v

20

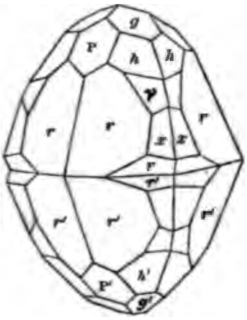
m m	65	50	principal rhombohedrons.
b b	63	51	
s s	61	25	
P *c*	134	36	
P *o*	135	23	

England.—In Cornwall and Devonshire low hexagonal prisms and tabular forms prevail, as represented in figures 7 and 10; also the forms *s g* and *o g*.

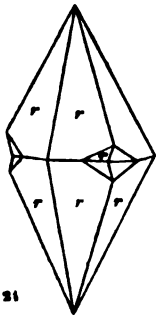
Cornwall; Wheal Buller, Redruth; Cadgwith Point; Binner Down near Helston; St. Just; Garras Mine near Truro. Polgooth near St. Austell. Tintagel quarries. Wheal Mary Ann, Menheniot. In skeleton crystals (*r t*) at West Grambler near Redruth.

Devonshire; at various mines at Beeralston and Beerferris. Wheal Friendship near Tavistock, in beautiful obtuse rhombohedrons of a pale lilac colour. Formerly in good crystals at the Breakwater quarries near Plymouth, in forms resembling figure 25, but with the faces *c f g r*. At Exeter, in amygdaloid.

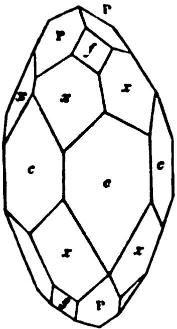
Derbyshire. The mountain limestone of this country is remarkable for the beauty of its crystals of calcite, which, notwithstanding the considerable size in which they are frequently met with, are usually well defined. Generally transparent or translucent, also white with a brownish yellow tinge. Figures 21 to 25 inclusive, may be taken as types of the forms most commonly met with. Among others P, and the combinations P*g*; P*g c f r*; P*g c m r s t*; *r*; *r c*; *r c g*; *m r f*; *m r f c*; *r c f g t*; *g t r m s*; *y r x*. Twins are common; among them occur the forms *t*, *r*, *θ*, *n*, *i*, *x*, *e*, *y*, *w*, all belonging to the class of scalene dodecahedrons, of which there are many more than those mentioned here. The form of crystal to which the term macle has been applied is also met with; among them the rare macles represented in figures 26 and 27, the former of which is known as the heart-shaped macle. There is likewise another macle very much resembling in its shape the blade of an axe. The chief localities are in the neighbourhood of Ashover, Bakewell, Castleton, Eyam, Matlock, Monsaldale, and Wirksworth. Lately, very fine, at Water Groove Mine at the top of Middleton Dale; at Eyam, and also at the Balls Eye Mine, Bonsall.


g
P
h
h
y
r
r
r
x
x
r
r′
r′
r′
r′
P′
h′
g′

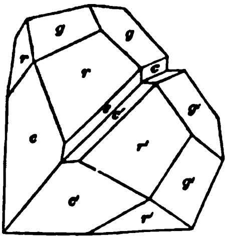
23



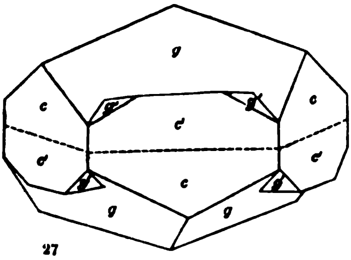
24


P
P
f
x
x
x
c
c
c
x
x
f
P

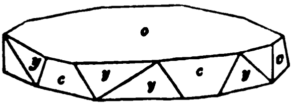
25


g
g
r
r
c
c
c
g′
r′
g′
c′
r′

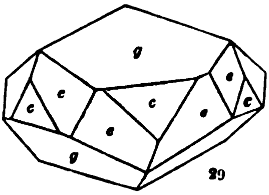
26


g
c
g′
c′
g′
c
c′
c
c′
g
g
g
g
g

27

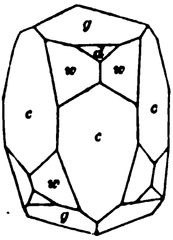


28


g
c
e
c
e
c
e
e
c
g

29

30



c c	120° 00′	*o g*	153° 45′	*u v*	90° 00′
c o	90 00	*r r*	144 20	*u u*	120 00
c g	116 15	*t t*	159 23	*w w*	155 30
o f	116 53	*u c*	150 00	*y y*	134 21

triangular prism resembling figures 18 and 19; colour pale-brownish.

Lanarkshire; at Bishoptown near Glasgow, in large crystals nearly transparent, and like those of Derbyshire in their general form.

Renfrewshire; Kilmalcolm, in transparent crystals of considerable size, coated with hydrous oxide of iron (figure 9), also the form *f*, with the obtuse solid angles replaced. At Roschalee quarry in the form of figure 23.

Dumbartonshire; many fine forms in Prehnite at Bowling and elsewhere.

Stirlingshire; at Alva.

Orkney; near Hoy Head.

Ireland.—Antrim; at Ballintoy with antrimolite, and at the Giant's Causeway, of a rich honey-yellow or orange-colour, sometimes locally called sugar-candy; at Tickmacrevan in large crystalline masses in chalk, often replacing and taking the form of the flints.

Clare; at Kingston Cave near Cahir.

Derry and Tyrone; in the carboniferous limestone of these counties numerous forms of crystallization occur.

Donegal; at Cloghan distinctly crystallized with pearl-spar.

Londonderry; at Donald's Mountain, in small well-defined crystals with pearl-spar; at Slieve Gallion, in fine six-sided prisms, and in the chalk in thin tabular crystals of a rose-colour; at Portstewart, in aggregated rhombohedral crystals, with a peculiar oily lustre.

Throughout the trap districts of Ireland, veins of calcite, generally of a yellow colour, are common. Fine specimens of doubly refracting spar have been found in the county of Mayo.

The lamellar variety, in very thin parallel layers, which the Germans call *schieferspath* (slate-spar), of a yellowish white colour, friable and tender, and with a pearly lustre, and which, by some continental mineralogists, is held to be a pseudomorphous form of calcite after gypsum, occurs at the following localities:—

Cornwall; at Botallack near St. Just; Delabole near St. Teath; North Roskear near Camborne; and at Polgooth Mine near St. Austell.

Devon; at Beeralston.

Lancashire; Coniston United Mine.

Scotland.—Argyll; Strontian. Ayrshire; Ballantrae. Perthshire; Glen Tilt. Sutherland; Assynt, in limestone.

Ireland.—At Kilkenny, and in Carlow and Kildare. Downshire; shores of the Morne Mountains. Longford; near Granard. Wicklow; Glandalough, or "Seven Churches;" Lugganure lead-mines near the same place.

Capillary calcite occurs in fossil shells in quarries in the neighbourhood of Bath.

The perfectly opaque variety coloured black by carbonaceous matter, to which the name of *anthraconite* has been given, and which emits a fetid odour on being rubbed, is common near Castleton and Matlock in Derbyshire; it occurs also at Swanage Bay, Dorset, along the Avon near Clifton, and near Sunderland.

The compact varieties, marble or limestone, variously coloured by admixture with silica, alumina, oxide of iron, or carbon, form the greater part of the transition and newer formations. Some of these, the *oolites,* consist of an aggregation of minute globules. Stalactites and tufa are continually forming, being deposited from water containing carbonate of lime dissolved in an excess of carbonic acid. *Stalactites* form mammillated or long fibrous masses in fissures and caverns in limestone rocks. Prevalent colour yellowish-white, also white and brown. Among British localities may be mentioned various caves at Matlock, Castleton, and Wirksworth in Derbyshire; they likewise occur, milk-white, at Hopton Moor in the same county. In Salop, at

Llanymynech in the Hundred of Upper Oswestry. In Yorkshire near Knaresborough, and at Yordas Cave near Ingleton. Also in the mines of Durham and Northumberland. Very fine in Macallister's Cave in the south of Skye, where they are sometimes coated with crystals of calcite.

Ireland.—Cork; near Blarney Castle, and in the parish of Carrigtohill. Clare; at Kingston near Cahir. Dublin county; at Castlenock four miles N.W. of Dublin. Kerry; in a cave near Ballymacelligot. Tipperary; very fine in a cave near Clogheen.

'Tufa,' an alluvial deposit from calcareous springs, is the most impure, irregular, and porous of all the varieties of calcite. On exposure it hardens so as to be used sometimes as a building-stone. Occasionally incrusts other substances, such as stems and leaves of plants; the water from which such deposits take place is usually termed in the neighbourhood a petrifying spring or well. Occurs at Matlock. At Summerstown in Oxfordshire. In Essex. Near Durham. In North Wales. At various calcareous springs in Scotland, and in the primary and secondary formations of Ulster.

'Chalk,' which was formerly considered as a variety of carbonate of lime, partakes of the character rather of a fossil than a mineral, inasmuch as it consists apparently in a great measure of an aggregation of fossils, chiefly infusorial.

'Agaric mineral,' or rock-milk, is of a white or yellowish-grey colour, soft and meagre to the touch. When dry, will float on water till the air in it is expelled; is pure carbonate of lime. Occurs in crevices of limestone rocks. At Banner Down near Bath; between the Isis and the Cherwell; and at Chipping Norton in Oxfordshire; near Sunderland.

In Brecknock, at Llangorse Pool, or Llyn Savaddan, on the river Llynvi. At Trevor near Llangollen, Denbigh. Near Edinburgh.

Londonderry; coating flint balls, at Slieve Gallion; in seams in new red sandstone at Aghanloo and Curly Burn. Near Poplar in Clare.

Plumbo-calcite of Johnston, is calcite containing a variable admixture of carbonate of lead. Is found at the High Pirn mine, Wanlockhead, Lanarkshire. Colour white, yellowish, grey; sometimes pinkish. Occurs in simple rhombohedral crystals. Cleavage rhomboidal (R. 104° 53′). Lustre pearly, somewhat less hard, but heavier than calcite, of which it can only be looked upon as a plumbiferous variety. Gr. 2·824.

Analyses of plumbo-calcite: *a*, from Wanlockhead, by Johnston; *b*, from Leadhills, by Delesse:—

	a.	*b.*
Carbonate of lime	92·2	97·61
Carbonate of lead	7·8	2·34
Water	...	0·05
	100·0	100·00

Dr. Heddle has a singular specimen of plumbo-calcite, presenting cubo-octahedrons of calcite after galena, in the interior of the rhombic crystals of plumbo-calcite!

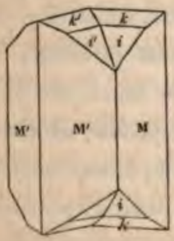
Among other varieties of calcite, may be mentioned *manganesian* carbonate of lime, of which a crystallized variety of a pinkish colour, containing 8 per cent. of carbonate of manganese, is met with in Nantlle Valley, Carnarvonshire.

'Magnesian carbonate of lime'. In a soft amygdaloid at Down Hill in Antrim, a curious mineral occurs, which is thus well described by Colonel Portlock in his Geological Survey of the N.E. of Ireland:—"It is oolitic in structure, consisting of spheroids, cemented together either by pure white carbonate of lime or by chlorite. In the latter case it has much the appearance of pudding-stone. The spheroids are yellow, whitish, or greenish, and appear to be a mixture of the hydrocarbonates of lime and magnesia. The small cavities are lined with drusy cavities of pure white carbonate of lime; where exposed, the cement yielding first, it assumes a mammillated appearance." Fracture very fine-grained. Does not adhere to the tongue. As this substance is very peculiar in appearance, and has been offered to collectors as hydrocarbonate of magnesia, the authors requested Dr. R. A. Smith, of Manchester, to oblige them by analysing it, which he has been so kind as to do with the following result, which shows that it is not even allied to hydro-magnesite :—

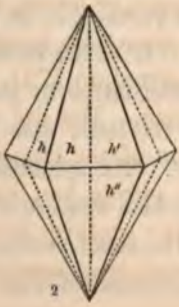
Carbonate of lime	91·50
Carbonate of magnesia	7·40
Water	0·67
	99·57

21. **STRONTIANITE.** — Strontianite, *Phillips, Brooke* and *Miller*; Strontiane carbonateé, *Hauy*; Strontianit, *Haidinger, Hausmann, v. Kobell, Naumann.*

Prismatic. Primary form a right rhombic prism of 117° 19′. Cleavage parallel to M, tolerably perfect. Fracture uneven. Translucent, transparent. Lustre vitreous, inclining to resinous on the surface of fracture. Colourless, but more frequently greyish, yellowish, and especially greenish (particularly pale asparagus-green or light apple-green), brown. Brittle. Seldom distinctly crystallized. Usually in attached crystals, which are often acicular and united in diverging groups; in columnar, fibrous, and compact masses. Twin face M. H. 3·5; Gr. 3·6 to 3·8.



1



2

MM	117° 19′	
k k	108 12	over summit.
i i	69 16	over summit.
k k	71 48	
i i	110 44	
h h	121 23	
h′ h″	140 28	

Before the blowpipe fuses in a strong heat, though only on the extreme edges, swells and puts forth cauliflower-shaped branches, shines brilliantly, and colours the flame red. Easily soluble in acids with effervescence. If the hydrochloric solution is evaporated, and the residue has alcohol added to it, the latter, on being set fire to, burns with a crimson flame. Isomorphous with Arragonite and Witherite.

Analyses of Strontianite: *a*, from Strontian, by Thomson; *b*, yellow, *c*, white, from Clausthal, both by Jordan; *d*, from Hamm, by Redicker; *e*, from the same locality, by Schnabel:—

	a.	*b.*	*c.*	*d.*		*e.*
Carbon. stron. . .	93·43	92·75	92·87	94·70		91·71
Carbon. lime . .	6·28	6·50	6·50	5·22		7·89
Carbon. protox. iron	0·01	0·36	...	...		...
Water	...	0·25	0·25	0·08	[$\ddot{\mathrm{Si}}$ and loss	0·40]
	99·72	99·86	99·63	100·00		100·00

$\dot{\mathrm{Sr}}\ddot{\mathrm{C}}$; strontia, 70·07; carbonic acid, 29·93. It always, however, contains an admixture of carbonate of lime, which in some varieties amounts to about 8 per cent. In the analysis given above under *e*, the ratio of the lime to the strontia is 1 to 8.

LOCALITIES.—*England.* Yorkshire; at Pately Bridge, and at Nidderdale, in crystals, snow-white and translucent, of the form of figure 2, and acicular.

Scotland.—Strontian in Argyleshire, occasionally crystallized in the form of figure 1, but usually acicular and diverging; very generally of a pale green, or brown, and likewise massive.

It was in the mineral from this locality that the late Dr. Hope of Edinburgh discovered, in 1791, the earth to which he gave the name of Strontian. The use of its salts is almost confined to the production of the crimson flame employed in artificial fireworks. The nitrate has, however, been recently used in photography. The greenish Arragonite found at Ballintoy, Antrim, Ireland, contains a sensible amount of Strontianite, as does also the Alstonite met with at Bromley Hill near Alston Moor, Cumberland, and at Hexham, Northumberland.

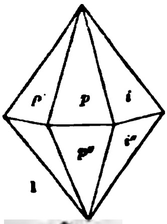
The 'Stromnite' or barystronianite of Dr. Traill, from Stromness on Pomona or Mainland, one of the Orkneys, and which occurs in yellowish-white aggregations with a dull pearly lustre, when fresh, is said to contain 68·6 Strontianite, 27·5 barytes, and some carbonate of lime. It is not a distinct species, but a mere mixture; it occurs at an old lead-mine two miles west of Stromness, and on the beach at the Point of Ness.

22. WITHERITE.—Witherite, *Phillips*, *Brooke*, and *Miller*; Baryte carbonatée, *Hauy*; Witherit of German mineralogists; Sulphato-carbonate of Barytes of *Thomson*.

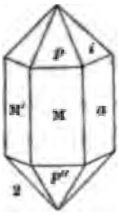
Prismatic. Primary form a right rhombic prism. Cleavage distinct, parallel to M, less so to *a* and *i*. Crystals nearly, if not always compound; the re-entering angles, however, are not always discernible, except in very perfect specimens. Twin face M. The faces M, *a*, *i*, and *p*, striated horizontally. Fracture uneven. Translucent, sometimes transparent. Streak white. Lustre vitreous, on the fracture resinous. The crystals not unfrequently coated with a dull cloudy crust. Colour white, inclining to grey or yellow, pinkish. Brittle. H. 3 to 3·5; Gr. 4·2 to 4·3.

The re-entering angles vary slightly in amount; for instance, from 177° 30′ to 179° 00′, apparently without any regular law. The faces *a* and *i* occur only in simple crystals, which are rare. Roughness or curvature of the faces *z* sometimes produces the appearance of a true terminal plane P, as does also the inverted or slightly concave termination represented in figure 5.

The following combinations occur on Fallowfield specimens in Mr. Greg's collection:—*p*; *z*; *p z*; M *z*; M *p*; M *p i*; M *p z*; M *p e h*; M *p e*; M *p e o z*; all apparently compound forms. On Dufton specimens: *p*; M *p z*; M *e p o z*.



1



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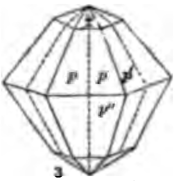

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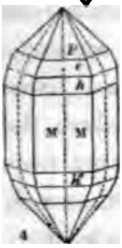

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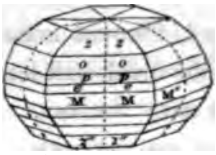

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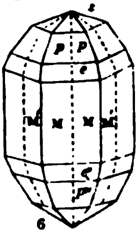

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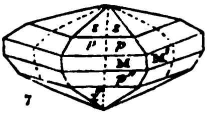


7

M M	178° 00′ re-entering angle			*i i''*	112° 00′ (?)
M M′	118 30			*p p*	178 30 re-entering angle
M *h*	161 00			*p p′*	130 13
M *e*	155 10			*p p''*	110 49
M *p*	145 25			*p i*	130 05 (?)
M *o*	125 56			*z z''*	42 10
M *z*	111 15	*h h''*	142 00	M *a*	120 45 (?)

Before the blowpipe fuses to a clear bead, which when cool is enamel-white; colours the flame of a yellowish-green; with soda on platina-foil melts into a transparent mass. On charcoal intumesces, becomes caustic, and is absorbed by the charcoal. Soluble with effervescence in dilute nitric acid.

Analyses of Witherite: *a*, from Anglezarke, by Withering; *b*, by Beudant.

	a.	*b.*
Carbonic acid	21·4	22·5
Baryta	78·6	77·1
Lime	...	0·4
	100·0	100·0

$\dot{\mathrm{B}}\mathrm{a}\ddot{\mathrm{C}}$; baryta, 77·59; carbonic acid, 22·41.

Occurs in attached crystals, more commonly in globular concretions, columnar and compact, usually associated with galena and barytes.

Localities. — *England and Wales.* Cumberland; Alston Moor, in crystals like fig. 5. Durham; at Welhope. Lancashire; at Anglezarke near Chorley, where this species was first discovered; it occurs there compact and fibrous, of a yellowish colour, inclining to grey.

In crystals of composition like fig. 1, at Arkendale in Yorkshire.

Shropshire; crystallized, fibro-columnar and compact, interspersed with barytes, at the Snailbeach lead-mines. Northumberland; at Fallowfield near Hexham. It is here that the finest crystals yet known are met with. They are frequently very perfect, and are occasionally remarkable for their size. All the forms represented in the figures occur at this locality, as do also all the combinations mentioned above. The largest crystals, having the form of figure 3, are often coated with a white deposit of barytes; sometimes, however, they are quite translucent, and occasionally 5 inches long. Flat or lenticular forms have been noticed, composed of only the low pyramid *z*. The sulphato-carbonate of barytes of Thomson, which in truth is Witherite with an exterior coating of minute crystals of barytes (see figures 5 and 7), is met with here, as well as at Dufton Fells. Crystals represented by figures 2, 4 and 6 are usually the most transparent.

Westmoreland; Dufton Fells, in double six-sided pyramids, sometimes hollow or coated with barytes, also in white orbicular concretions, and in aggregated crystals of a white colour. Likewise in the form of figures 5 and 7. It was to these forms of this mineral that Thomson refers under the title of '*sulphato-carbonate of barytes.*' Occurs also at this locality in hollow pseudomorphs with the form of barytes.

Yorkshire; Arkendale.

Isle of Man; at Foxdale lead-mine.

Wales.—Flintshire, near St. Asaph.

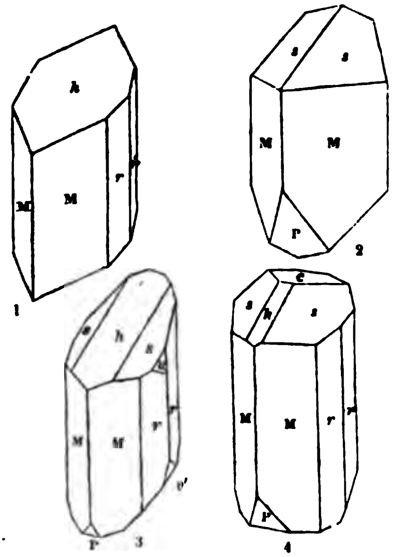
At Fallowfield this substance is extensively worked by Messrs. Walton and Cooper. It is employed in this country in chemical works and in the manufacture of plate-glass; it is likewise exported to France, where it is used in the preparation of beet-root sugar.

Note.—Analyses by Heddle of the sulphato-carbonate of barytes: *a*, from Hexham; *b*, from Dufton:—

	a.	*b.*
Carbonate of baryta	98·96	99·24
Sulphate of baryta in minute crystals	·94	·54
Carbonate of lime	trace	·22
	99·90	100·00

23. BARYTOCALCITE.—Barytocalcite of English, American and French authors; Barytocalcit of German mineralogists.

Oblique. Primary form an oblique rhombic prism. Cleavage perfect parallel to *s* and P. The faces striated parallel to their intersection with each other. Fracture imperfect conchoidal, uneven. Transparent to translucent. Lustre vitreous, inclining to resinous. Colourless, greyish, yellowish, greenish-white. Streak white. Brittle. H. 4; Gr. 3·6 to 3·7.



M M	95° 08′
h M	110 20
P M	140 30
P *s*	102 54
P *c*	147 34
h c	138 34
r r	146 06
s s	106 54
v v'	112 00
v h	124 00
s h	143 27

Combinations: P M *s*; M *r s*; M *r h*; P M *r h s*; P M *r h s c*; P M *r h s v*, all in specimens from Alston Moor, in Mr. Greg's collection. The solid angle M M *h*, sometimes truncated, but not measurable. Before the blowpipe infusible, becomes cloudy, and at last gives an alkaline reaction. With borax, fuses with effervescence to a clear bead. Decomposed with soda, which is absorbed with the barytes by the charcoal leaving the lime behind. Soluble with effervescence in hydrochloric acid.

Analyses of barytocalcite: *a*, by Children; *b*, by Delesse:—

	a.	*b.*
Carbonate of baryta . . .	65·9	66·20
Carbonate of lime . . .	33·6	31·89
Silica	...	0·27
	99·5	98·36

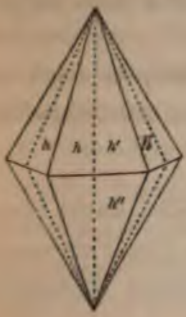
$\dot{\mathrm{Ba}}\ddot{\mathrm{C}}+\dot{\mathrm{Ca}}\ddot{\mathrm{C}}$, which would give carbonate of baryta, 66·1; carbonate of lime, 33·9.

LOCALITY.—At Bleagill, Alston Moor, Cumberland, in attached crystals and massive, in veins in mountain limestone. It is a plentiful mineral there. The crystals are usually greyish-white, and semi-transparent. From half an inch to an inch in length generally speaking, but crystals 2 inches long are sometimes met with. These large crystals are coated over with a deposit of barytes. A similar deposit is sometimes noticed upon smaller crystals, which in that case not unfrequently have their regularity of form quite destroyed.

Naumann, in his chemical characters of this species, alludes to the presence of manganese. He however probably refers to the *other* $\dot{\mathrm{Ba}}\ddot{\mathrm{C}}+\dot{\mathrm{Ca}}\ddot{\mathrm{C}}$, Alstonite, in which, from one locality at least, that metal has been shown to be present.

24. **ALSTONITE.**—Alstonite, *Brooke* and *Miller*; Bicalcareo-carbonate of Barytes, *Thomson*; Bromlite, *Johnston*; Baryto-calcite en prisme droit, *Dufrénoy*; Alstonit, *Breithaupt*, *Hausmann*, *Haidinger*, *Naumann*.

Prismatic. Primary form a right rhombic prism. Isomorphous with Witherite, Strontianite, Arragonite and cerussite. Fracture conchoidal, uneven. Cleavage tolerably distinct. Colourless, greyish-yellow, pink tinge. Lustre vitreous, on surfaces of fracture resinous. The face *h* striated across. Twins. Twin-face M. Streak white. H. 4 to 4·5; Gr. 3·65 to 3·7.



h' h''	142° 00'	
h' h'	122 30	
h h'	178 50	re-entering angle.

Before the blowpipe decrepitates and phosphoresces. Decomposed by carbonate of soda upon charcoal, into which the barytes sinks, leaving the lime. Soluble in acids with effervescence.

Analyses of Alstonite: *a*, from Bromley Hill, by Johnston; *b*, from Fallowfield, by Delesse; *c*, from Fallowfield, by Thomson; *d*, by Hauer:—

	a.	*b.*	*c.*	*d.*
Carbonate of baryta .	62·16	65·31	60·63	65·71
Carbonate of lime . .	30·29	32·90	30·09	34·29
Carbonate of strontia	6·64	1·10	...	...
Carbonate of manganese	...	0·16	9·18	...
Silica	...	0·20	...	traces
	99·09	99·67	99·90	100·00

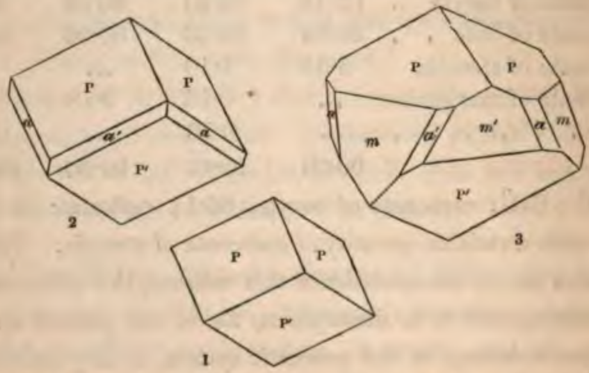
$\dot{Ba}\ddot{C}+\dot{Ca}\ddot{C}$; carbonate of baryta, 66·1; carbonate of lime, 33·9, with a variable quantity of carbonate of strontia. Taking this view of the composition of this mineral, the substance of Alstonite appears to be dimorphous, for in the present species its crystals belong to the prismatic system, in barytocalcite to the oblique system; but the result given in the last of the three analyses cited above, differs so materially from those of the two preceding ones, that it does not by any means seem clearly established that Alstonite and barytocalcite are in truth chemically identical.

Localities.—*England.* Cumberland; at Bromley Hill near Alston, in small acute six-sided pyramids of a white or grey colour, in veins with galena.

Northumberland; Fallowfield near Hexham, in small six-sided pyramidal crystals, of a pinkish tinge, with crystallized Witherite.

25. **DOLOMITE.**—Dolomite, *Brooke* and *Miller, Dana*; Bitter-spar, *Phillips*. Brown-spar. Pearl-spar. Chaux carbonatée magnésifère, *Hauy*; Bitterkalk, *Hausmann*; Braunspath, *Naumann*; Dolomit, *v. Kobell*; Conite.

Rhombohedral. Cleavage perfect parallel to P; faces of cleavage generally curved; the faces P sometimes very rough and convex, leading to curved or saddle-shaped forms. Lustre vitreous, often pearly or resinous. Fracture conchoidal. Semi-transparent to translucent. Colourless or white, generally however reddish, yellowish, or greenish, but commonly pale in colour. Streak greyish-white. Brittle. H. 3·5 to 4·5; Gr. 2·85 to 2·95.



P P 106° 15′ to 20′ P P′ 73° 55′ *a a′* 120° 00′ *m m′* 113° 53′

Combinations: P; P *a*; P *m a*.

An elevation to the temperature of boiling water alters the angle between the cleavage planes 4′, making them assume a position more nearly at right angles to each other.

Infusible before the blowpipe, but becomes caustic. With fluxes usually gives the reactions of iron or manganese, sometimes of both. Moistened with hydrochloric acid, most varieties effervesce but little if at all, and even when in powder are not usually completely soluble, unless with the application of heat. According to v. Zehmen, when Dolomite, in the form of a very fine powder, is exposed for a few minutes upon platina foil over a spirit-lamp, it remains a loose powder, though intumescing to a certain extent while red-hot.

Analyses of Dolomite: *a*, in colourless crystals, from Jena, by Suckow; *b*, compact, from Ihlefeldt, by Rammelsberg; *c*, from the Zillerthal, by Meitzendorf; *d*, granular, from the Valley of Sambuco, by Abich:—

	a.	*b.*	*c.*	*d.*
Carbonate of lime . .	55·2	55·62	56·66	56·57
Carbonate of magnesia .	44·7	42·40	38·60	43·43
Carbonate of iron . .	...	0·56	3·30	...
Carbonate of manganese	...	...	1·70	...
	99·9	98·58	100·26	100·00

$\dot{Ca}\ddot{C}+\dot{Mg}\ddot{C}$; carbonate of lime, 54·18; carbonate of magnesia, 45·82=100. This is the constitution of what may be called normal Dolomite; but most varieties contain also carbonate of iron or manganese, or both together.

In attached and imbedded crystals, granular and columnar masses, disseminated, pseudomorphous after calcite. The white granular variety of Dolomite forms rocks by itself and beds in other rocks. The red and brown varieties, with lustre inclining to pearly (pearl-spar, brown-spar), occur chiefly in Great Britain, in veins associated with blende and galena.

Localities.—*England.* It is a common mineral at many places, so much so that only some of its localities can be mentioned here.

Cornwall; plentifully near Redruth; at Wheal Castle; at Garras mine near Truro. In obtuse rhombohedrons in Trevaskus and N. Roskear copper-mines, and at Polgooth tin-mine.

Cumberland; at Nenthead, Ogill Burn, Old Haggs, Garrigill and Cole Cluff; at Alston with fluor, plentifully, usually in curved rhombs, the edges of which sometimes meet; colour generally brownish; at the Cleator iron-works near Whitehaven.

Devonshire; very fine at South Hooe near Beer Ferris. With fluor at Beeralston.

Durham; a *flexible* schistose Dolomite, of a pale brownish-yellow, occurs at Marsdon Hill near Sunderland; and in the quarries of Building Hill, near the same place, an opaque and earthy variety, in globular and radiated concretions.

Gloucestershire; Forest of Dean, in small reddish crystals.

Westmoreland; at Ulleswater, in white curved crystals.

Worcestershire; at the Bredon Hills, crystallized and massive.

Common at so many of the Derbyshire lead-mines, that the precise localities cannot be given in detail.

Isle of Man; in remarkably fine crystals at Foxdale lead-mines.

Wales.—Carnarvonshire; with malachite and calcite at Great Orme's Head near Llandudno. Common at many of the Welsh lead mines.

Scotland.—Aberdeenshire; at Tyre Bagger. Argyleshire; in Iona. Buteshire; in Bute, in fine iridescent curved rhombohedrons. Dumbartonshire; near Loch Lomond. Lanarkshire; at Leadhills, formerly, in clear white pearly crystals, of the form of figure 1. Wigtonshire; near Newton Stewart, in very fine pale lilac-coloured crystals.

Ireland.—Londonderry; in small well-defined crystals, in limestone, at Dungiven. At Banagher, at Borenagh, at Ballynascreen. Of various shades, from yellowish-brown to rich straw-yellow, with high pearly lustre, in the limestone of Desertmartin. At Donald's Mountain, of a rich yellowish-green or oil-green, crystallized, and in spherical masses, in dark green amygdaloid.

Louth; flesh-coloured, lamellar, at Whitestown.

M. Durocher is of opinion that the assumption of some geologists, that Dolomite has been formed naturally by aqueous agency, is proved by an experiment of his not to be absolutely correct, as it may have been formed by magnesian vapours issuing from the interior of the earth, gradually converting limestone into Dolomite.

This species was named in honour of Dolomieu.

The *Conite* of Friesleben and John may be a subspecies of Dolomite.

Analyses: *a*, from Meissner, by John; *b*, from Co. Derry, by Dr. R. A. Smith:—

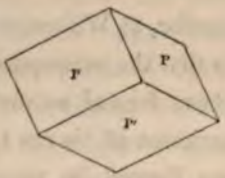
	a.	*b*.
Carbonate of lime	28·0	22·10
Carbonate of magnesia . .	67·4	71·50
Carbonate of iron	3·5	4·50
	98·9	98·10

Formula, ? $\dot{Ca}\ddot{C}+3\dot{Mg}\ddot{C}$; with carbonate of lime, 28·28; carbonate of magnesia, 71·72.

Occurs amorphous and yellowish-white in amygdaloid, at Down Hill, Co. Derry, in Ireland; also similarly in Mull and Skye (?).

26. **BREUNERITE.**—Breunnerite, *Brooke* and *Miller*; Breunerit, *Haidinger*, *Hausmann*; Talkspath, *G. Rose*, *Naumann*; Magnesit, *v. Kobell*. Carbonate of Magnesia and Iron.

Rhombohedral. P. 107° 10′ to 107° 30′. Cleavage very perfect parallel to P. P even, but rough. Fracture conchoidal. Transparent to translucent on the edges. Lustre vitreous, inclining to pearly on cleavage surfaces. Colourless, yellowish-white, yellow, brown. Streak greyish-white. Brittle. H. 4 to 4·5; Gr. 2·9 to 3·1.



P P 107° 23′.

Infusible before the blowpipe, usually turning grey or black, in which latter case it becomes magnetic. With soda, sometimes yields indications of manganese. Generally, even when reduced to powder, it is only soluble in acids with the aid of heat.

Analyses of Breunerite: *a*, from the Zillerthal, by Stromeyer; *b*, from the Tyrol, by Brooke:—

	a.	*b.*
Carbonate of magnesia . . .	84·79	86·05
Carbonate of iron	13·82	13·15
Carbonate of manganese . . .	0·69	...
	99·30	99·20

$(\dot{M}g, \dot{F}e)\ddot{C}$; carbonate of magnesia, with a variable quantity of carbonate of iron, amounting in some cases to 17 per cent. Occasionally it contains a little carbonate of manganese, not, however, above 3 per cent.: may be generally taken as $9\dot{M}g\ddot{C}+\dot{F}e\ddot{C}$; with carbonate of magnesia, 87·05; carbonate of protoxide of iron, 12·95.

Usually occurs in detached imbedded crystals, of the primary form, in chlorite talc and serpentine. It is likewise met with in columnar and granular masses.

LOCALITY OF BREUNERITE.—Hitherto it has been met with in the United Kingdom only at the head of Norwick Bay in Unst, one of the Shetlands, where it occurs in small yellowish-brown rhombohedral crystals, imbedded in apple-green foliated talc.

The name Breunerite was given to this species by Haidinger in compliment to Count Breuner.

27. ANKERITE.—Ankerite, *Haidinger, Dana, Rammelsberg*; Dolomite (in part).

Rhombohedral. P P′=106° 12′. Cleavage parallel to P perfect. Fracture uneven. Translucent on the edges. Lustre vitreous to pearly. Colour yellowish or reddish-white; becomes brownish on exposure. Brittle. H. 3·5 to 4·0; Gr. 3·0.

With blowpipe becomes magnetic; with soda gives indications of manganese; imparts the colour of iron to borax. Soluble with effervescence in acids.

Analyses: *a*, by Berthier, from Golrath in Styria; *b*, from Tinzen in the Grisons, by Schweizer; *c*, communicated by Haidinger; *d*, from Hoher Wand, Styria, by Schrötter; *e*, by John; *f*, from Corniglion; *g*, from Mühlen; *h*, from Villefranche, all by Berthier:—

	a.	*b.*	*c.*	*d.*
Carbonate of lime	51·1	46·40	48·03	50·11
Carbonate of magnesia . . .	25·7	26·95	16·46	11·85
Carbonate of protoxide of iron	20·0	25·40	32·06	35·31
Carbonate protox. manganese	3·0	...	2·97	3·08
	99·8	98·75	99·52	100·35

	e.	*f.*	*g.*	*h.*
Carbonate of lime	50·00	50·9	50·5	60·9
Carbonate of magnesia . .	8·40	29·0	32·4	30·3
Carbonate of protoxide of iron	35·0	18·7	12·3	6·0
Carbonate protox. manganese	5·0	0·5	...	3·0
	98·4	99·1	95·2	100·2

Formula, $2(\dot{\mathrm{Fe}}\dot{\mathrm{Mn}})\ddot{\mathrm{C}}+3\dot{\mathrm{Mg}}\ddot{\mathrm{C}}+5\dot{\mathrm{Ca}}\ddot{\mathrm{C}}$; with carbonate of lime, 51·02; carbonate of magnesia, 25·88; carbonate of protoxide of iron, 23·10; some of the latter being replaced by manganese. In *c*, *d*, and *e* carbonate of protoxide of iron gradually replaces carbonate of magnesia, till in John's analysis the formula is nearly $3\dot{\mathrm{F}}\mathrm{e}\ddot{\mathrm{C}}+\dot{\mathrm{M}}\mathrm{g}\ddot{\mathrm{C}}+4\dot{\mathrm{C}}\mathrm{a}\ddot{\mathrm{C}}$; with carbonate of lime, 48·54; carbonate of magnesia, 10·26; carbonate of protoxide of iron, 41·19; while in *f*, *g*, and *h* magnesia replaces protoxide of iron till the mineral approximates to Dolomite.

Localities.—Has been lately noticed by Dr. Heddle, massive, and in simple curved crystals, in amygdaloid, near Torness in the Orkneys.

28. HYDROCALCITE.—Hydrous Carbonate of Lime, *Scheerer*.

Rhombohedral. Incrusting and amorphous. Whitish, bluish, greyish. Gr. 2·58.

Analysis from the Giant's Causeway, by Da Costa :—

Lime	47·0
Carbonic acid	36·0
Water	12·0
Silica	3·0
Alumina	2·0
	100·0

Formula, $4\dot{\mathrm{C}}\mathrm{a}\ddot{\mathrm{C}}+3\dot{\text{Ħ}}$; with lime, 49·67; carbonic acid, 38·56; water, 11·77.

Occurs in contact with the basalt of the Giant's Causeway; of a greenish-grey colour, translucent, semi-hard, with a splintery fracture and glimmering lustre, easily broken.

29. PENNITE.—*Hermann*; Hydronickelmagnesite, *Shepard*.

Incrusting, with the surface often consisting of minute elongated globules. Colour whitish, with a tinge of green or blue. Lustre weak. H. 3·0; Gr. 2·86.

Before the blowpipe infusible. With borax, intumesces and forms a brownish-red gloss in the outer flame.

Analysis of a specimen from Texas, Pennsylvania, by Hermann :—

Carbonic acid	44·54
Lime	20·10
Magnesia	27·02
Oxide of nickel . . .	1·25
Protoxide of iron . . .	0·70
Protoxide of manganese .	0·40
Alumina	0·15
Water	5·84
	100·00

Formula, $\dot{\mathrm{C}}\mathrm{a}\ddot{\mathrm{C}} + 2\dot{\mathrm{M}}\mathrm{g}\ddot{\mathrm{C}} + \dot{\mathrm{H}}$; with carbonic acid, 45·71; magnesia, 28·47; lime, 19·62; water, 6·20; some of the magnesia being replaced by oxide of nickel.

Occurs with emerald nickel on chromate of iron, according to Dr. Heddle, at Swinaness, and massive foliated at Haroldswick, in Unst, Shetlands.

30. HYDROMAGNESITE, *Kobell*, *Dana*; Hydrocarbonate of Magnesia, *Thomson*.

Monoclinic. Crystals small, acicular, and bladed. Also amorphous, and in chalky crusts. Lustre vitreous to subpearly. Also earthy, transparent, colourless. Streak white. Brittle. H. 3·5; Gr. 2·14 to 2·18.

B.B. infusible; yields moisture, and finally becomes pure magnesia. Effervesces and dissolves in acids.

Analyses: *a*, from Hoboken, by Walterhausen; *b*, from Negroponte, by v. Kobell; *c* and *d*, from Texas, Pa., by Smith and Brush:—

	a.	*b.*	*c.*	*d.*
Magnesia . . .	42·41	43·96	43·20	42·30
Carbonic acid . .	36·82	36·00	36·69	36·74
Water	18·53	19·68	19·43	20·10
Silica	·57	·36	...	...
	98·33	100·00	99·72	99·14

Formula, $\dot{\mathrm{M}}\mathrm{g}^4\ddot{\mathrm{C}}^3 + 4\dot{\mathrm{H}}$; with magnesia, 43·9; carbonic acid, 36·3; water, 19·8.

This species has been lately found by Dr. Heddle, earthy and in minute shining crystals, associated with Brucite at Swinaness, Isle of Unst, Shetlands.

The largest crystals were not one-eighth of an inch in length; the form appears to be identical with that given in Dana's 'Mineralogy,' 4th Edition, p. 456, as belonging to the crystallized hydromagnesite of Hoboken, New Jersey; and the faces I, *ii*, and 22 were distinctly measurable.

Order VIII. OXIDES.

31. BRUCITE, *Haidinger, Phillips*; Native Hydrate of Magnesia.

Rhombohedral. Cleavage basal, perfect. In six-sided tables; usually foliated, fibrous or massive, rarely botryoidal. Lustre pearly. Colour white, inclining to grey, blue or green. Streak white. Translucent, subtranslucent. Sectile; thin laminæ flexible. H. 1·5 to 2·0; Gr. 2·35.

Before the blowpipe becomes opaque and friable, but does not fuse; gives off water in the open tube. Entirely soluble without effervescence in acids; gives the test of magnesia.

Analyses: *a*, from Unst, by Stromeyer; *b*, by Fyfe, also from Unst; *c*, from Hoboken, New York, by Stromeyer:—

	a.	*b.*	*c.*
Magnesia	66·67	69·75	68·34
Protoxide of manganese	1·57	...	0·64
Protoxide of iron . .	1·18	...	0·12
Lime	0·19	...	...
Water	30·39	30·25	30·90
	100·00	100·00	100·00

Formula, $Mg\dot{H}$; with magnesia, 68·97; water, 31·03.

Localities.—At Swinaness in the Isle of Unst, Shetlands, where it occupies considerable veins in serpentine; occurring in aggregated, foliated plates of a silvery white colour and translucent.

On exposure becomes white, absorbing carbonic acid from the air.

Order IX. ANHYDROUS SULPHATES.

32. ANHYDRITE, *Phillips*; Karstenite, *Haidinger*; Muriacite. Anhydrous Sulphate of Lime.

Prismatic, with two perfect cleavages. Also curved, fibrous, lamellar, and granular. Lustre pearly, vitreous. Colour white, with frequently a pinkish or bluish tinge. Streak greyish-white. Fracture uneven; splintery. H. 3·0 to 3·5; Gr. 2·92.

May be distinguished from gypsum, with which it is frequently associated, by its superior hardness.

Before the blowpipe melts with difficulty into a white enamel. With fluor forms a clear white bead; with borax a yellow one when cold. Slightly soluble in water and in muriatic acid.

Contains, when pure,—

Sulphuric acid	58·47
Lime	41·53
$\dot{\mathrm{Ca}}\dddot{\mathrm{S}}$.	100·00

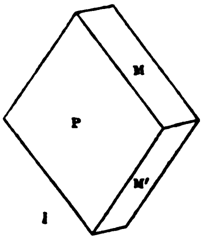
Occurs at Aston-on-Trent near Derby, in the gypsum pits; of a pale blue colour and granular; also with gypsum at Newark in Notts.

Of a pale blue colour, fibro-lamellar and translucent, in trap-rock on the Cave Hill near Belfast.

33. BARYTES.—Baryte, *Brooke* and *Miller*; Barytes, *Dana, Phillips.* Heavy Spar. Cawk. Baryte sulfatée, *Hauy*; Baryt, *Haidinger, Hausmann, v. Kobell, Naumann.*

Prismatic. Primary form a right rhombic prism. Cleavage

M and P perfect, especially P; *a*, *b* less perfect. Fracture conchoidal, seldom observable, uneven. Transparent to translucent. Lustre vitreous, inclining to resinous. Colourless, white, blue, grey, yellow, brown, red. Streak white. Brittle. H. 3 to 3·5; Gr. 4·3 to 4·7. (According to G. Rose, the normal Gr. = 4·48.)



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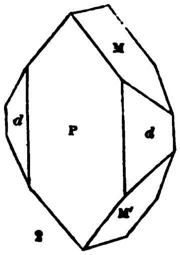

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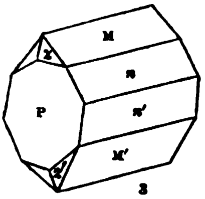

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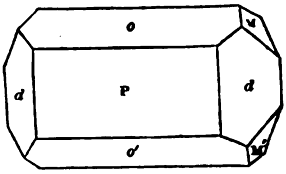

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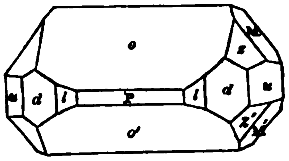
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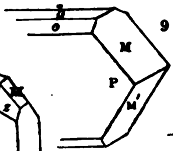

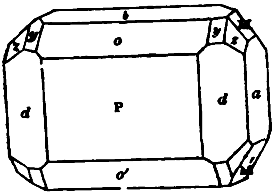
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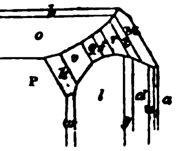

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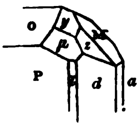


7

M M'	101°	40'	P *f*	145°	17'	*b z*	134°	19'	*u u*	63°	39'
P M	90	00	P *r*	133	54	P *o*	127	18	*o o*	74	36
M *a*	129	10	P *z*	115	42	P *d*	141	09	λ λ	135	40
P *a*	90	00	P *μ*	142	24	*w w*	149	56	*η η*	123	00
P *b*	90	00	P *y*	123	00	*l l*	136	07	*φ φ*	113	26
P *k*	165	24	*b a*	90	00	*g g*	123	32	*γ a*	104	05
P *v*	157	26	*b f*	116	12	*i i*	115	40	(*l*, *d*, *i* new		
P *q*	152	38	*b y*	116	02	*d d*	102	17	faces).		

Combinations observed on Dufton specimens in Mr. Turner's and Mr. Greg's collection: M P; M P *b*; M P *d*; M P *a*; M P *d η*; M P *d n*; M P *o l*; M *o d y*; M P *o d*:—(M P *o d*) *b*, *a*, *η*, *l u*, *l u z*, *b w l*, *b φ*, *b φ w*, *w l u*, *a b y z*, *a w l u y z*, *b w u z*, *b i v z*, *a l μ z*, *a l μ y z*, *a b w l y μ z*, *w l g u q z*, *a y z l u y λ*, *a b k v q f r z w l g u*, *a b λ u z*, *b l u z y μ*, *a b l u y z*. Cornish forms: (M P) *o*, *o a*, *b o d*, *o d u*, *η z*, *η o z*. Arran forms: P *o l i d v q z*; M P *d b o l i d u v q z*; M P *b o i d v z*. The form *φ* truncates the edge P *o*; *λ* and *η*, the edge M *b*; and *γ*, the solid angle *b z u*.

Before the blowpipe it decrepitates violently, and melts with great difficulty, or is only rounded on the edges, imparting a yellowish-green colour to the flame; with soda on platina foil it fuses into a *transparent* mass; the variety in curved aggregated plates when thus treated melts into an *opaque* mass, owing to the presence of undissolved lime. In the reducing flame it yields sulphuret of barium, which, when moistened with hydrochloric acid, does not tinge the flame of alcohol red. Not attacked by acids.

Analyses of barytes: *a*, from Nutfield, by Stromeyer; *b*, from Görzig, in Anhalt-Köthen, by Rammelsberg; *c*, granular, from Wiesbaden, by Fresenius; *d*, compact, from Clausthal, by Jordan (? *cawk*).

	a.	*b.*	*c.*	*d.*
Sulphate of baryta . .	99·38	83·48	89·47	86·00
Sulphate of strontia .	...	15·12	1·85	6·75
Peroxide of iron . .	0·05	...	0·29	...
Sulphate of lime . .	...	0·89	...	...
Silica	...	0·25	8·15	5·75
Water	0·07	...	0·08	0·38
	99·50	99·74	99·84	98·88

$\dot{\mathrm{B}}\mathrm{a}\dddot{\mathrm{S}}$; baryta, 65·63; sulphuric acid, 34·37=100; a portion of the baryta is sometimes replaced by strontia.

In crystals, fibrous, compact, stalactitic, and earthy. In beds and veins in various formations. Pseudomorphous, as at Dufton, after Witherite.

Localities.—*England.* Cheshire; of a pink colour, in sandstone at Alderley Edge.

Devon; at Babicombe, in small tabular crystals.

Cornwall; formerly, in flat crystals, at the United Mines. At the Royal Iron Mine, Lostwithiel. At Cakes and Ale Mine. Near St. Day. Lately, fine, near St. Austell. Beautifully crystallized at Herodsfoot near Liskeard, recently. Also in fine transparent crystals, tinged yellowish, or tipped with yellow on face *o*, accompanied with pyrites or fluor, at Wheal Mary Ann near Liskeard, presenting the form of figures 2 and 4: the combination M P *o d u* occurs here; sometimes the crystals at this locality are tabular, at others pointed. At three or four mines in the parish of Menheniot. The variety once known on the Continent by the name of "*wolnyn*," figure 3, has been met with lately in Cornwall. The face P is uppermost, and the form is at first not easy to recognize as barytes. Colour pale yellow, crystals nearly transparent, and disposed on vesicular iron ore. Fig. 9 represents a Cornish form.

Cumberland; in fine detached blue translucent crystals, M P *d n*, at Hinniside near Egremont; at Cleator Moor iron-mines in fine yellowish-white translucent crystals, like figure 2, dagger-shaped. At the mines at Alston; Bolegap, Greenside, Saddleback, Drygill, Potsgill, and Rotherhope Fell. At Roughtengill, with malachite, in small transparent crystals of the form M P *a*. Large opaque crystals, tipped with yellow, at Force Craig near Keswick. The variety known as *cocks-comb* barytes, an aggregation of small opaque and greyish-white crystals, occurs at the Cumberland and Lancashire localities; in curved plates at Patterdale; also crystallized at Carrock Fells.

Derbyshire; in nodules just below the surface, at Matlock and at Redland near Buxton. In black radiating and lamellar masses, impregnated with manganese, at Middleton by Youlgrave. Stalactitic, very fine, with concentric and radiating markings of a rich brown, in a field at Newhaven near the last-mentioned place. The variety called cockscomb-barytes is common at Derbyshire localities. *Hepatite*, an impure spar emitting a fetid odour on friction, occurs at Buxton, Eyam, and Matlock. An opaque massive variety, of an earthy appearance and dirty-white colour, has been called *cawk*; it is very common in Derbyshire with galena, it occurs also at Grassington in Yorkshire, and in Staffordshire.

Devonshire; on calcite at Babicombe, and in many other quarries near Torquay.

Durham; at Hartlepool.

Gloucestershire; at Clifton. With galena at Durdham Down.

Herefordshire; two miles and a half S. of Ledbury, of a red colour.

Kent; radiated and crystallized in septaria with calcite, on W. side of Isle of Sheppey.

Lancashire; of a pale blue, fibrous, like celestine, at Liverpool, in sandstone. At Anglezarke Moor near Chorley.

Northumberland; at Burton.

Salop; with Witherite at Snailbeach; and at Middleton Hill.

Somerset; at Watchett, and at Clevedon.

Stafford; well crystallized, at Breaston Hill, and also at Ecton.

Surrey; in honey-yellow elongated crystals, figure 5, in fullers-earth pits at Nutfield, three miles E. of Reigate; also, M P *d*; M P *o d l u z*.

Westmoreland; at Patterdale in large yellowish-white curved and aggregated plates. The finest crystals, however, found in the United Kingdom have come from the neighbourhood of Dufton. They are very perfect and large, often transparent, sometimes white, yellowish, or brown. Figures 1, and 4 to 8 inclusive, with combinations mentioned in a preceding part of this article. At Silverband near Dufton, large detached crystals, very perfect, occur, lying in the mud at the bottom of a cavern. One of these crystals has been found weighing a hundred-weight. At Dufton a variety also occurs, with the form of figure 1, laterally aggregated and prettily grouped, colour pale yellow. Pseudomorphous, in hollow doubly terminated six-sided pyramids (originally Witherite), at Dufton Fell. A Dufton specimen, in Mr. Greg's collection, contains drops of some fluid.

Yorkshire; at Arkendale; at Grassington, the earthy variety called *cawk*.

Isle of Man; at the Foxdale mines.

Scotland.—Argyleshire; at Strontian. In the Island of Bute. Edinburghshire; well-defined crystals, of primary form, in greenstone, at Edinburgh. At Habbies Howe massive and lamellar; flesh-coloured at the Braid Hills. Elgin; at Quarry-wood. Perthshire; at Ballindean, of a bright sulphur-yellow. Inverness. In conglomerate, in Island of Lewis, Hebrides. Lanarkshire; at Leadhills, in small transparent crystals, of the form of figures 1 and 2, and M*ody*; also in white lamellar masses. At Cumberhead lead-mine. Linlithgowshire; near Linlithgow, with blende and galena. Renfrewshire; at Eaglesham. Stirlingshire; at Alva. At Airthrie, or Airthsay Wells, Ochill Hills. Arran; in small transparent crystals, observed by Dr. Heddle, at Glen Sannox, with the forms P*olidvqz*; MP*dboliduvqz*; MP*boidvz*; the form *i*, between *g* and *d*, not having been before described.

Ireland.—Cork; at Audley copper-mines near Clonakilty; in granular masses on the sea-shore; also at Glandore, massive; and at Bandon. Dublin; at Killiney. Londonderry; at Ballynascreen, forming thick veins in old red sandstone; also at Slieve Gallion. Tyrone; near Clogher, of a reddish colour. Wicklow;

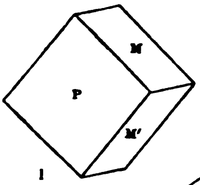
at Lugganure near Glendalough, in thin transparent yellow crystals. At Glenmalure.

The white varieties of barytes are heated, thrown into water, then ground up and used for adulterating white-lead. It has been recently proposed to employ barytes in sugar refining. In 1855 there were raised in the United Kingdom about 2000 tons of barytes.

The name barytes is derived from *βαρὺς*, *heavy*.

34. CELESTINE.—Celestine, *Brooke* and *Miller*, *Dana*, *Phillips*; Strontiane sulfatée, *Haüy*; Cölestin, *Haidinger*, *Hausmann*, *Naumann*, *v. Kobell*.

Prismatic. Primary form a right rhombic prism. Of the same general forms as barytes and Anglesite. Cleavage very perfect parallel to P, less so to M. Fracture imperfect conchoidal. Transparent, translucent. Occasionally colourless, frequently bluish-white, bluish-grey, smalt-blue to indigo-blue, seldom reddish or yellowish. Lustre vitreous, slightly pearly on P and on the surfaces of perfect cleavage. Brittle. H. 3 to 3·5; Gr. 3·9 to 4.



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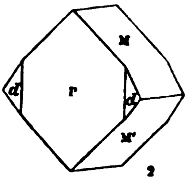

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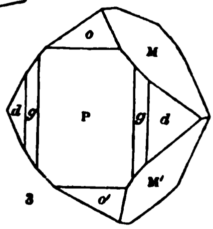


3

P M	90° 00'
M M'	104 02
P *d*	140 35
P *g*	151 17
P *o*	127 56
d d	101 11
o o'	75 52

Combinations: P M; P M *d*; P M *o g*; P M *o g d*, on specimens from Bristol.

Decrepitates before the blowpipe, and melts tolerably easily into a milk-white bead. Colours the flame carmine, especially, according to v. Kobell, when the assay, after exposure to the reducing flame, has been moistened with hydrochloric acid. On charcoal in the reducing flame yields sulphuret of strontium; if this is dissolved in hydrochloric acid, the solution evaporated, and then has alcohol added to it, the flame of the latter becomes coloured carmine. But sparingly attacked by acids. Phosphoresces when thrown in powder on a hot iron.

Analyses of celestine: *a*, radiated, from Girgenti; *b*, fibrous, from Dornburg.

	a.		*b.*
Strontia . . .	56·35		56·27
Sulphuric acid .	43·08		42·95
Alumina . . .	...		0·05
Peroxide of iron .	0·03		$\dot{\mathrm{F}}\mathrm{e}$ 0·03
Carbonate of lime	0·09		0·10
Water	0·18	with bituminous matter.	0·11
	99·73		99·51

$\dot{\mathrm{S}}\mathrm{r}\dddot{\mathrm{S}}$; sulphuric acid, 43·64; strontia, 56·36=100.

Occurs in crystals, and in fibrous, lamellar and compact masses, with sandstone, marl, and gypsum.

Localities.—*England.* Cornwall; at Binner Down mine, four miles north of Helston.

Devonshire; in transparent crystalline plates, on gypsum, at Sidmouth, where it also occurs in flints.

Gloucestershire; very beautiful, perfect, transparent crystals, from a quarter of an inch to an inch in length, were met with in making the railway-cutting at Pyle Hill near Bristol. Colour pale blue and yellowish, with the forms given in the figures. The matrix was red marl and sandstone. It occurred there also fibrous, fibro-lamellar, granular and compact. Figure 1 is a rare form. In the neighbourhood of Bristol it occurs in granular masses in considerable quantity, so much so as to be employed for the preparation of the nitrate of strontia, which forms the basis of the composition of the crimson flame used in pyrotechny. At Clifton; at Aust Passage.

Northumberland; radiated, of a pale blue, at Burton.

Somersetshire; at Berkeley; in the bed of the river at Bedminster Bridge; in crevices in yellow sandstone at Redland near Brislington; in lenticular masses in limestone near Watchett; near Bath. Yorkshire; white and opaque at Scotton Moor, and in the Nidd near Knaresborough, in the magnesian limestone.

Wales.—Glamorganshire; on Barry Island, eight miles S.E. of Cowbridge.

Scotland.—Edinburgh; in cutting for the foundation of George the Fourth's Bridge, and in small foliated masses, in trap, at the Calton Hill. Elgin; in small white translucent crystals, in sandstone, near Elgin. N. Haddington; pale blue, diverging, forming veins in trap, on the shore facing the Bass Rock, and at several other places on the coast. Inverness; crystallized, in sandstone, near Inverness.

The name celestine is derived from *cœlestis*, sky-blue, a colour which, however, is not by any means characteristic of the species.

35. MASCAGNINE.—Sulphate of Ammonia.

Prismatic. Usually in crusts, or stalactitic. Lustre, when crystallized, vitreous. Colour yellowish, greyish. Translucent. Taste pungent and bitter; easily soluble in water, and attracts moisture from the atmosphere. H. 2·2; Gr. 1·7.

Before the blowpipe decrepitates, melts, and finally volatilizes, yielding a smell of ammonia.

Contains—

Sulphuric acid	53·28
Ammonia	22·81
Water	23·91
$NH^4\dddot{S}+2\dot{H}$.	100·00

Usually found near the craters or fissures of volcanoes and lava, along with sal-ammoniac.

At Bradley in Staffordshire, in ignited coal-beds.

36. EPSOMITE, *Beudant*. Sulphate of Magnesia. Epsom Salt.

Prismatic. Primary form, a rhombic prism of 90° 30′ and 89° 30′. Usually in fibrous crystalline or botryoidal masses; rarely pulverulent. Lustre vitreous. Colour white or grey; transparent to opaque. Taste bitter and saline. Brittle. H. 2·25; Gr. 1·75.

Soluble in less than double its weight of cold water, and occurs indeed as a constituent of many mineral waters. Does not effervesce in acids. Before the blowpipe deliquesces, but is with difficulty fusible before the water of crystallization is driven off.

According to Haidinger and Mitscherlich, sulphate of magnesia is dimorphous.

Contains—

Sulphuric acid	32·36
Magnesia	16·68
Water	50·96
$\dot{\mathrm{M}}\mathrm{g}\dddot{\mathrm{S}}+7\dot{\text{Ħ}}$	100·00

Occurs in an efflorescent state at Epsom in Surrey, hence its name. In coal-mines near Newcastle in Northumberland in a crystalline state. At Hurlet near Paisley in Scotland, in white silky and capillary crystals, which effloresce on the sides of the alum mines.

The Epsom salt of commerce and pharmacy is usually obtained chemically from the magnesian limestone of Yorkshire.

37. ALUM.—Potash Alum. Alum Salt.

Cubic. Usually occurs in nature in fibrous masses, or in an efflorescent state. Colour white; translucent. Taste astringent, rather sweetish. H. 2·3; Gr. 1·75. Soluble in from 16 to 20 times its own weight of cold water, and little more than its own weight of boiling water. On exposure to heat melts in its own water of crystallization, and froths up in a remarkable way. Heated to redness, sulphurous acid is disengaged.

Contains—

Sulphuric acid	33·76
Alumina	10·82
Potash	9·95
Water	45·47
$\dot{K}\dddot{S}+\dddot{\bar{A}l}\,\dddot{S}^3+24\dot{\bar{H}}$.	100·00

Localities.—In this country it chiefly occurs in what is called *alum shale*, which is found principally in the lias near Whitby, on the coast of Yorkshire, where it is extensively worked; at the Newport slate quarries in Pembrokeshire; in clay at Chudleigh in Devon.

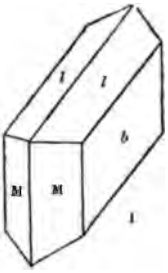
At Moffat and Hartwell Spa in Dumfriesshire; in considerable quantity in shale at Hurlet near Paisley; at Ferrytown of Cree in Kirkcudbrightshire.

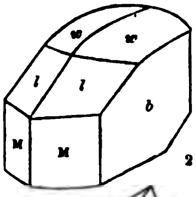
Along the coasts of Clare and Kerry on the west coast of Ireland.

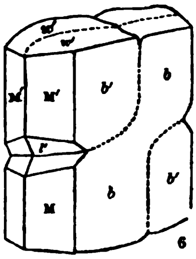
Alum is used in the manufacture of leather and paper, in dyeing, in medicine, and for preserving animal substances. (See Appendix, No. 4.)

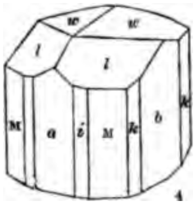
38. GYPSUM, *Phillips*; Gyps, *Haidinger*, *Hausmann*. Selenite. Chaux sulfatée, *Hauy*.

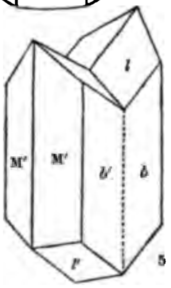
Oblique. Cleavage highly perfect parallel to *b*. Twin face parallel to *a*. *m*, *b* striated parallel to their intersections with each other; *e*, *l*, *w*, *n* frequently rough or curved, leading to lenticular forms, as in fig. 3. Colourless, white, blue, red, yellow, grey, brown. Lustre pearly and shining parallel to *b*. Flexible in thin plates. The rings surrounding the optic axes are dissimilar. Streak white. Sectile. H. 1·5 to 2·0; Gr. 2·28 to 2·33.

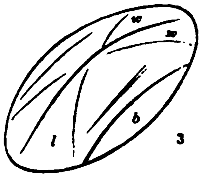












M M	111° 42′		*l b*	108° 09′		*b i*	107° 30′
M *a*	145 41		*e a*	87 58		*b a*	90 00
M *l*	131 00		*b k*	153 59		*b w*	97 52
l l	143 42		*b* M	124 19		*b n*	110 46

Forms. M *b l*; M *a b l*; M *b l w*; *b l w*; M *b l w n*; M *a b i k l w*; M *b l n e*. For the forms *e* and *n*, see Brooke and Miller; *i* not before described; the forms *w* and *e* not easily distinguished from each other when rough or curved.

Heated in the glass tube yields water. Before the blowpipe becomes white and opaque, and melts into a white enamel. Very slightly soluble in water. At a temperature of about 140° C. the water escapes, and it becomes friable; mixed with water in this state, it combines again, becomes hot, and grows hard. Slightly soluble in acids.

Consists of—

Sulphuric acid	46·31
Lime	32·90
Water	20·79
$\dot{\mathrm{Ca}}\ddot{\mathrm{S}}+2\dot{\mathrm{H}}$.	100·00

Occurs in attached or imbedded crystals; also fibrous globular, compact, granular, earthy, and lamellar. Is common in the old and new red sandstone formations, in marl and red clay, or in the neighbourhood of beds of rock-salt; also in peat beds, fossil shells, and with sulphur and celestine; it is rare in the older rocks.

Selenite is a name usually applied to the more shining and transparent varieties; *satin-spar* to the fibrous varieties, and *alabaster* to the compact white variety; the two latter much used for ornamental purposes.

LOCALITIES.—*England*; at Long Crendon in Bucks.

Cheshire; in the marls of the salt districts, masses of selenite are of common occurrence.

Cumberland; at Alston Moor, with earthy red iron ore, in clear colourless crystals with the form of fig. 4.

Cornwall; at Huel Fanny, lately.

Essex; at Walton-on-the-Naze, in stellated and acicular crystals in clay.

Gloucestershire; at Aust Passage, and at the Pyle Hill Railway-cutting near Bristol, in transparent foliated masses enclosing crystals of celestine; also pretty generally in the clays of the new red sandstone.

Glamorganshire; of a reddish colour at Penarth and Cardiff.

Kent; in the gault near Folkstone; in Isle of Sheppey.

Lincoln; foliated and fine at Epworth, in the Isle of Axholme.

Northumberland; at old workings of the Felling Colliery, in delicate white acicular crystals, and in elongated twin crystals (fig. 5) of a brownish-yellow colour. At New Biggan.

Oxfordshire; in the clay at Shotover Hill, in very large perfect and detached crystals (figs. 1, 2, 3, 5 and 6), transparent, and of a greyish-white colour; some of these crystals are of remarkable size, weighing from one to two pounds, and doubly terminated; small crystals occur at this locality in fossil oyster-shells.

Somerset; at Windford, at Watchett near Mine Head in marl, and near Clifton.

Surrey; in the London clay.

Wilts; at Telsford in fine detached crystals, like those from Shotover.

Warwickshire; in red marl, near the surface.

Westmoreland; at Acornbank near Temple Sowerby.

Worcestershire; in red marl, as at Hadbury.

Isle of Wight; at Alum Bay.

Yorkshire; at Ferry Bridge (West Riding) in marl.

Scotland.—Berwickshire; in the red clay on the banks of the Whitadder. Dumfriesshire; at Moffat, in new red sandstone. Renfrewshire; at Hurlet near Glasgow, in ferruginous earth near the coal and alum shales.

Ireland.—Antrim; at Kilroot near Carrickfergus, in large transparent and aggregated crystals, over the salt-bed at that place. Donegal; in rolled lumps (not *in situ*) in Ballintemple Glen, parish of Erigal. Leitrim; near Lough Allen. Ulster; in flattish crystals of a grey colour in clay-slate.

Alabaster occurs also in England, principally at Chellaston and Ashton-on-Trent, in Derbyshire, in red marl, at both which places it is extensively worked, being used for ornamental purposes; also at Tutbury and Bennington Hall, both compact and granular. Glamorganshire; obtained in large quantities at Penarth, Cardiff, Leckwith, and Lavenock. Compact or *granular* at Newark in Notts; at Fauld in Staffordshire; at Old Clive in Somerset; at a quarry between Penrith and Carlisle in Cumberland; in Monaghan Co., Ireland.

Plumose and acicular at Cumberland mine near Matlock.

Fibrous gypsum, or *satin-spar*, occurs in fine specimens at Red Hill and Newark in Notts; at Chellaston in Derbyshire;

pale blue in Gloucestershire; and near Carrickfergus, Co. Antrim, in Ireland.

Gypsum, besides being used for ornamental purposes, is also used as a manure to neutralise acidity in land, and in the manufacture of certain kinds of glass and porcelain.

'Plaster of Paris' is gypsum that has been heated, and afterwards ground into powder.

39. WEBSTERITE, *Levy*; Aluminite, *Jameson*; Sub-sulphate of Alumina, *Phillips*.

Reniform, massive, impalpable. Lustre dull, earthy. Opaque. White. Fracture earthy. Adheres to the tongue, and is meagre to the touch. Yields to the nail. H. 1·0 to 2·0; Gr. 1·66. Fuses with difficulty. Easily soluble in muriatic acid without effervescence. Absorbs water. With a solution of cobalt becomes blue. At 100° C. gives off half its water.

Analyses: *a*, by Stromeyer, from Newhaven, Sussex; *b*, from Halle, also by Stromeyer:—

	a.	*b.*
Alumina	29·87	30·263
Sulphuric acid . .	23·37	23·365
Water	46·76	46·372
	100·00	100·000

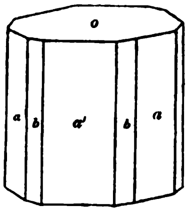
Formula, $\ddot{\mathrm{A}}\mathrm{l}\dddot{\mathrm{S}}+9\dot{\mathrm{H}}$; with alumina, 27·80; sulphuric acid, 23·25; water, 46·95.

Localities.—Occurs in reniform masses, or in botryoidal concretions, on the sea-beach near Newhaven in Sussex; and in a ferruginous clay resting upon the chalk strata of the overhanging cliffs; it has probably a recent origin. Also, according to Portlock, in thin seams and earthy, in the fissures of the greenstone, on calcite near Portrush, Co. Antrim.

Order X. PHOSPHATES.

40. APATITE, *Brooke* and *Miller*, *Dana*, *Phillips*; Chaux phosphatée, *Hauy*; Apatit, *Haidinger*, *Hausmann*, *v. Kobell*, *Naumann*.

Rhombohedral. Cleavage *o* and *a* imperfect. Fracture conchoidal, more or less perfect, uneven. Transparent, translucent. Lustre vitreous, inclining to resinous, sometimes adamantine. Prisms usually striated vertically. Colourless, white, green, blue, violet, red, grey; the colours, however, usually pale. Streak white; dichromatic. Brittle. H. 5; Gr. 3·16 to 3·22.



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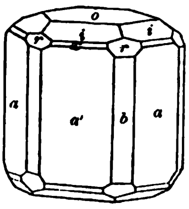

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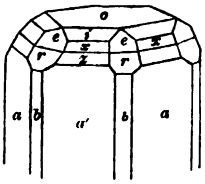

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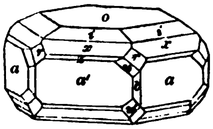


4

a a′	120° 00′	*i o*	157° 05′	*u a*	149° 38′
a b	150 00	*x o*	139 47	*r a*	135 39
a o	90 00	*z o*	120 36	*u o*	110 03
e o	143 47	*x x*	142 20	*h u*	169 06
r o	124 20	*r r*	131 14		

Combinations: *oa*; *oab*; *oabi*; *oai*; *oabir*; *oabixr*; *oabhixzur*; *oabreixz*: *h*, *u* are hemihedral with parallel faces; *h* replaces edge *b a*.

Before the blowpipe fusible only in thin splinters, and that with difficulty. When moistened with sulphuric acid, the powder supported in a loop of platina wire, tinges the flame bluish-green. Soluble in considerable quantity in salt of phosphorus, forming a clear glass, which when tolerably saturated becomes opaque on cooling, and shows crystalline faces. Soluble with difficulty in boracic acid; with iron wire yields phosphuret of iron. With salt of phosphorus mixed with oxide of copper, gives the reaction of chlorine; with salt of phosphorus in the open tube, or with sulphuric acid, that of fluorine. The presence of the lime is only to be manifested in the moist way. Soluble in nitric or hydrochloric acid.

Analyses of apatite: *a* and *b*, variety called *Francolite*, by Henry:—

	a.	*b.*
Phosphoric acid	41·34	41·80
Lime	53·38	52·81
Protoxide of iron and $\dot{\mathrm{Mg}}$.	2·96	3·22
Fluorine and loss . . .	2·32	2·17
Chlorine	trace	trace
	100·00	100·00

$3\dot{\mathrm{Ca}}^3\overset{\cdot\cdot\cdot}{\ddot{\mathrm{P}}}+\mathrm{CaFl}$; this is the formula of the variety called *Francolite*: see analyses *a*, *b*. For apatite, where chlorine is present as well as fluorine, the formula is $3\dot{\mathrm{Ca}}^3\overset{\cdot\cdot\cdot}{\ddot{\mathrm{P}}}+\mathrm{Ca}(\mathrm{Fl},\mathrm{Cl})$, which latter expression requires lime, 49·66; phosphoric acid, 42·58; calcium, 4·06; chlorine, 0·07; fluorine, 3·63=100; or lime, 55·17; phosphoric acid, 41·48; hydrochloric acid, 2·10; fluosilicic acid, 1·25=100. The solution in nitric acid of the variety containing chlorine gives a precipitate with nitrate of silver.

In attached and imbedded crystals, massive, earthy. In granite, gneiss, mica-slate, hornblende slate, in veins of tin ore.

LOCALITIES.—*England.* Cornwall; of a greyish-blue, in Gilbertite, at Stenna Gwynn near St. Austell. Yellowish-green between Botallack and Wheal Cock. In fine, brilliant, bluish-green crystals, in tin veins at St. Michael's Mount with topaz; also, at the same place, in small highly modified transparent crystals, with the faces of figure 4, on felspar. On quartz in small greenish crystals, with calcite, at Wheal Kind near St. Agnes. At Fowey Consols, recently, the variety called *Francolite* has been met with. It occurs in minute crystals slightly curved, in small stalactitic crystallized masses, and in thin plates, associated with quartz and chalcopyrite, white and translucent. It has been found also at this locality in thin hollow cubes above an inch square, which, when first discovered, are half filled with a transparent fluid. This variety was termed Francolite from having been found originally at Wheal Franco near Tavistock.

Cumberland; in fine celandine-green crystals (bluish-green with grey), nearly transparent, sometimes measuring an inch in each direction, and of the form of figures 1 and 3, engaged in quartz and Gilbertite, at the foot of Brandygill, Carrock Fells. Very fine specimens have been met with recently.

Devonshire; in large and fine crystals, of a cream-colour and translucent, in a quarry at Bovey-Tracey near Chudleigh. Figures 1 and 2, and also combination *o a b i*. The crystals are occasionally two inches long, and are associated with splendid crystals of black tourmaline. Unfortunately for collectors of the present day, this locality has been long since exhausted; but they should not fail to keep a look-out in adjoining quarries. At Wheal Franco near Tavistock, some years ago, in small stalactitic crystalline masses, greyish-green to brown.

Scotland.—Aberdeenshire; fibrous and acicular at Dee Side. With porphyry, in the fields, in Kildrummy parish. Ross; grass-green in quartz.

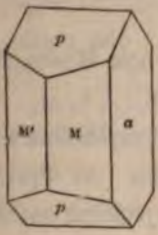
Ireland.—Antrim; yellowish-white, in doubly-terminated six-sided prisms, in a basaltic dyke near Kilroot. In Donegal.

Down; small yellowish-white crystals, in granite, near Hilltown. Dublin; at Threerock Mountain, in granite, in light-green translucent six-sided prisms, with the lateral edges replaced. At Killiney Hill, of a pale sea-green, fine six-sided prisms, in limestone.

The name apatite is derived from ἀπάτη, *deception*, with reference to the mistakes of the earlier mineralogists relative to the nature of its numerous varieties.

41. **WAVELLITE.**—Wavellite, *Brooke* and *Miller*, *Dana*, *Phillips*, *Dufrénoy*; Wavellit, *Haidinger*, *Hausmann*, *v. Kobell*; Wawellit, *Naumann*.

Prismatic. Primary form a right rhombic prism. Cleavage M and *a* tolerably perfect. Fracture imperfect conchoidal. Translucent. Lustre vitreous; on M pearly. The faces M striated vertically. Colourless, generally however greyish or yellowish, sometimes of a rich green or blue. Streak white. Brittle. H. 3·5 to 4; Gr. 2·3 to 2·5.



M M'	126° 25'
p a	90 00
p p	73 14

In the matrass yields water, and frequently traces of hydrofluoric acid. Exposed to the blowpipe flame in the forceps it intumesces, the flame assuming a pale bluish-green tint, more especially when previously moistened with sulphuric acid. On charcoal it intumesces and becomes snow-white. With solution of cobalt it becomes blue. Soluble in acids or in caustic potash. Heated with sulphuric acid, it frequently evolves fluorine.

Analyses of Wavellite: *a*, from Barnstaple, by Fuchs; *b*, from Barnstaple, by Berzelius; *c*, blue, *d*, green and yellow, from Langen Striegis, both by Erdmann:—

	a.	*b.*	*c.*	*d.*
Alumina . . .	37·20	35·35	36·60	36·39
Peroxide of iron .	...	(and $\ddot{\mathrm{M}}$) 1·25	1·00	2·69
Phosphoric acid .	35·12	33·40	34·06	33·28
Lime	...	0·50	...	...
Hydrofluoric acid	...	2·06	trace	trace
Water	28·00	26·80	27·40	27·10
	100·32	99·36	99·06	99·46

$\mathrm{AlFl^3+3(\ddot{A}l^4\overset{\cdot\cdot\cdot\cdot\cdot}{P}{}^3+18\dot{H})}$, or, as the analysis would give it, alumina, 36·53; phosphoric acid, 35·14; hydrofluoric acid, 3·23; water, 26·58=101·48.

In acicular radiating crystals, and in hemispherical, botryoidal and reniform aggregations, having a drusy surface.

LOCALITIES.—*England.* Cornwall; on a decomposing granite at Stenna Gwynn near St. Austell, often accompanied with fluor and fluellite.

Devonshire; in crevices in slate near Barnstaple, at which locality it is abundant.

Northumberland; on sandstone near Newcastle.

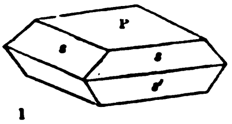
Scotland.—In the Shiant Islands.

Ireland.—Cork; bright green in crystalline radiating aggregations at Traeton, on black killas. At Springfield Abbey. Tipperary; in dark apple-green crystalline masses, beautifully mammillary, at Clonmel.

This species is named after Dr. Wavell, by whom it was discovered near Barnstaple.

42. CHILDRENITE, *Levy*.

Prismatic. Primitive form a right rhombic prism, M M probably =92·48. Cleavage indistinct parallel to P. Fracture uneven. Lustre vitreous, inclining to resinous. Colour yellowish-white, brownish-yellow, brown. Streak paler than the colour. Translucent. H. 4·5 to 5·0; Gr. 3·2.



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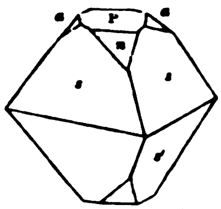

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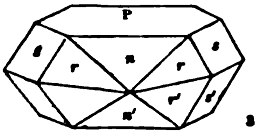

3

P*r*	109° 53′	(adjacent)	*r r*′	119° 32′	*n n*′	75° 46′
P*s*	114 58		*r r*″	105 10	*r s*	168 29
P*n*	142 07		*s s*′	130 04	*r n*	139 08
P*a*	152 22		*s s*	102 41	*s n*	137 26
r′ *r*″	140 04					

Yields water on exposure to heat, colours flame of blowpipe bluish-green; not fusible; with fluxes shows the reactions of iron and manganese. Somewhat difficultly soluble in hydrochloric acid.

The best analysis, by Rammelsberg, afforded him—

Phosphoric acid	28·92
Alumina	14·44
Protoxide of iron	30·68
Protoxide of manganese	9·07
Magnesia	0·14
Water	16·98
	100·23

Formula, $2(\dot{Fe},\dot{Mn})^4\ddot{\bar{P}}+\ddot{Al}^2\ddot{\bar{P}}+15\dot{H}$, with the iron to the manganese as 3 to 1 = protoxide of iron, 28·72; protoxide of manganese, 9·72; alumina, 14·00; phosphoric acid, 29·16; water, 18·40. With the iron to the manganese as 4 to 1, the per-centages are, protoxide of iron, 30·65; protoxide of manganese, 7·79.

Childrenite was first noticed by M. Levy, who named it after

Mr. Children, and was at first a very rare mineral; it has never been found out of this country, and the following are its correct localities and history:—

In minute crystals on siderite and pyrites, about fifty years ago, in cutting a canal near Tavistock; and soon afterwards it was met with in small distinct crystals, like figure 2, at Crinnis mine near St. Austell. About three years since Mr. R. Talling, of Lostwithiel, re-discovered this substance in minute crystals near Tavistock; and still more recently in very large and brilliant crystals, like figure 3, at the George and Charlotte mine, between Callington and Tavistock. The last mine at which specimens were found is Wheal Crebor, also near Tavistock, and there it occurs (though rarely) in distinct crystals of the form of figure 1, imbedded in a greyish-green chloritic earth.

Childrenite may be mistaken for siderite, but the crystals have superior lustre as well as hardness. The largest crystal yet found was nearly an inch in length, and came from the George and Charlotte mine.

Order XI. SILICA AND SILICATES.

43. **QUARTZ.**—Quartz, *Phillips*, *Brooke* and *Miller*; Quarz, *Hauy*, *Hausmann*, *Haidinger*, *Naumann*. Berg-crystal.

Rhombohedral. Hexagonal forms with pyramids prevail. Cleavage P, *b*, *z* imperfect; fracture conchoidal and splintery. Not unfrequently twinned, with the axial system of the individuals parallel; very rarely with the axes of the individuals inclined at an angle of 84° 33′. Occasionally in juxtaposition, and sometimes in individuals interpenetrating each other, presenting the appearance of a simple crystal, figure 10. Twin-face sometimes P.

Faces of the hexagonal prism, *b*, striated horizontally. In the variety termed amethyst the fracture often presents numerous delicate rippled lines, somewhat resembling those observable in the palm of the hand. This is due to the crystal being composed of layers having opposite optical properties. When a slice of amethyst or of a twin crystal bounded by planes perpendicular to the axis is placed in a polarizing apparatus, the portions of the individuals of which it consists are distinguishable from each other by a difference of colour when they have opposite optical properties. These plates, and other apparatus for the examination of minerals by polarized light, may be obtained of Mr. W. H. Darker, Optician, Paradise Row, Lambeth.

Colourless and white, the prevailing colour; also yellow, brown, blue, pink, purple, black. Transparent, translucent. Lustre vitreous, on surfaces of fracture inclining to resinous in some varieties. Gives sparks with steel. On rubbing two pieces together in the dark, a phosphorescent light and a faint empyreumatic odour are emitted. The phosphorescence is observable under water. Exhibits double refraction and circular polarization. H. 7; Gr. 2·5 to 2·8; in the purest varieties 2·65.

The crystals sometimes include foreign matter, for instance, capillary crystals of epidote, rutile, amphibole, Göthite, thin scales of mica, pearl-spar, bitumen, and other minerals, and more sparingly drops of a very expansible liquid.

British forms. P; Pz; Pzb; $Pzbs$; $Pzbx$; $Pzbx\zeta$; $Pzbxmf$; $Pzbxm\phi$; $Pzbx\beta f\phi e$; $Pzbxsyf\gamma\beta h\ (\phi)$*.

The faces s, v, x, y are hemihedral, occurring in alternate and opposite positions, except in the case of twin crystals, when they occur with greater apparent regularity; s and x are always subordinate. There is a great want of variety exhibited in the crystalline forms of quartz met with in the United Kingdom, the form Pzb being nearly universal; the most highly modified crystals are from Cairngorum and the Mourne Mountains. Crystals of quartz, especially those of the variety termed rock-

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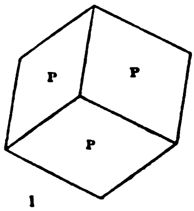
* See also page 87 for Mourne Mountain forms.



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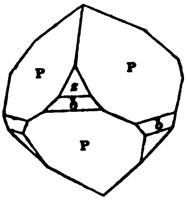

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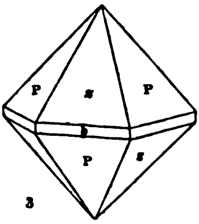

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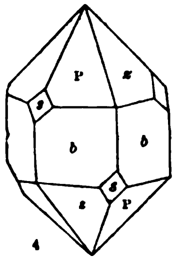

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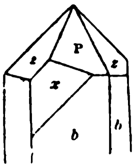

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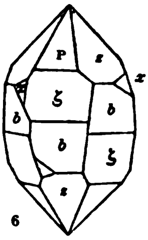

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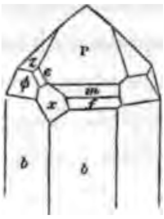

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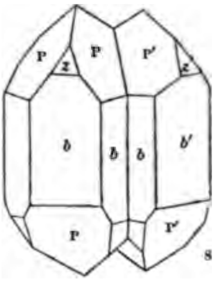
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z
P
P′
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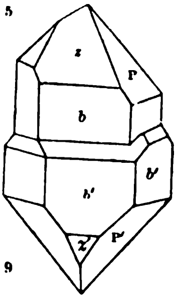
b
b
b
b′
P
P′

8



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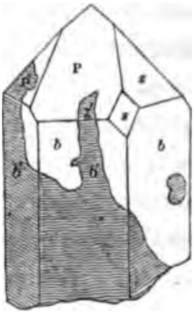

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P P	94° 15′	*b e*	154° 55′	*b z*	141° 47′	*b m*	165° 28′
P *z*	133 44	*b y*	165 25	*b″h*	167 19	*b γ*	168 52
P *b*	158 31	*b x*	167 59	*b″φ*	173 35	*b f*	171 51
b b	120 00	*b v*	151 08	*b β*	154 43	*b ζ*	172 31
b s	142 02						

crystal, have frequently their similar planes in one and the same form very dissimilarly developed, thus rendering the forms liable to very remarkable distortions. This holds good especially with respect to P, *z* and *b*.

See Brooke and Miller's edition of Phillips on Quartz, p. 245; also Descloiseaux's 'Mémoire sur les formes et la structure intérieure du Quartz.'

Infusible before the blowpipe. With soda fuses with intumescence into a clear glass. Insoluble in all acids except hydrofluoric acid. Scarcely attacked even when in powder by a solution of caustic potash.

Analyses of quartz: *a*, rock-crystal, by Bucholz; *b*, amethyst, by Rose; *c*, prase, by Beudant; *d*, iron-flint or ferruginous quartz from Sundwich near Iserlohn, by Schnabel:—

	a.	*b.*	*c.*	*d.*
Silica	99·37	97·50	94·84	94·93
Alumina	trace	0·25	0·47	0·42
Peroxide of iron . .	...	0·50	$\dot{\mathrm{F}}\mathrm{e}$ 3·64	3·93
Oxide of manganese .	...	0·25	...	...
Water	...	...	1·05	0·73
	99·37	98·50	100·00	100·01

When pure is $\dddot{\mathrm{S}}\mathrm{i}$, consisting of silicon 48·04, and oxygen 51·96.

According to Fuchs the colour of the rose-quartz found at Rabenstein in Bavaria is due to the presence of from 1 to 1·5 per cent. of oxide of titanium. From the experiments of Wolff, it appears that the specific gravity of neither this variety of quartz nor that of smoky quartz is materially altered by exposure to a red heat. The purple colour of amethyst was formerly supposed to be due to manganese. Heintz, however, observed that a very deep purple Brazilian amethyst contained at most 0·01 per cent. of manganese, and that it became colourless at 250° Centigrade, so that this metal could not be the cause of its colour. In a paler Brazilian specimen he found red oxide of iron, 0·0197; lime, 0·0236; magnesia, 0·0133; soda, 0·418. This discoloration by heat and the presence of soda bear out the idea, originally broached by Poggendorff, that the colour of amethyst is due to the presence of a minute quantity of ferric acid.

In attached and imbedded crystals globular, reniform, stalactitic, fibrous and compact. Pseudomorphous after datholite, barytes, fluor.

The following classification of the numerous varieties of quartz is taken from Naumann's 'Mineralogy':—

a. Rock-crystal.—LOCALITIES.—Cornwall; at the Tintagel slate-quarries and in the cliffs there in clear crystals, fit for ornamental purposes, of the form of figure 1 and figures 3 to 6 inclusive. In the cliffs at Delabole near St. Teath. At Swanpool. Formerly at Wheal Diamond and Wheal Alfred. Lately fine, with fluor, at Wheal Mary Ann. Enclosing schorl at Boscawen Cliff near Penzance. At Mainforth near Falmouth, in the forms of figures 1 and 2. Yellow at the Carnbrae mines.

Cumberland; at Brandygill, Tentergill and Potsgill on Carrock Fells; at Caldbeck Fells, and at Falcon Craig near Keswick. In various forms at Alston with blende and fluor. In very fine clear crystals on hæmatite at Cleator Moor iron-mines.

Devonshire; in fine crystals 5 or 6 inches long, containing chlorite and studded with smaller crystals round about the lower end in the manner of a ruff, at Wheal Friendship near Tavistock, in form of figure 5. Figure 9 represents a post-natal twin, occurring in large opaque reddish crystals at North Bovey.

Derbyshire; at Castleton with blende; at Masson Low or Heights of Abraham.

Gloucestershire; at Clifton, with the forms 1 to 4 inclusive, known as "British diamonds."

Hampshire; at Undercliffe, Isle of Wight.

Lancashire; at the Ulverston iron-mines in the form of fig. 3, also P z, with hæmatite.

Northumberland; Allenheads.

Shropshire; at Snailbeach with calcite.

Somersetshire; at Cheddar in geodes.

Wales.—Carnarvon; Snowdon, very fine.

Scotland.—Rock-crystal occurs in various parts of Scotland, as in mica-slate, figures 1 and 2, on the north shore of Holy Loch, Argyleshire; and in calcite at Bishop's Hill. At Leadhills *pseudo* after barytes and Anglesite; in the neighbourhood of Cairngorum or Cairngorm, that is to say, "blue mountain," in the S.W. of Banff, where it is met with in the forms $\mathrm{P}\,b\,z$; $\mathrm{P}\,b\,z\,x\,m\,f$; $\mathrm{P}\,b\,z\,x\,\beta\,f\,\phi\,e$, and figure 7. Usually wine-yellow or brown, sometimes black. These crystals occasionally weigh 25lbs. They are much sought after for ornamental purposes, and are well known by the name of *Cairngorums.* The Rev. J. Stewart, in a letter with which he has favoured the authors, remarks that "rock-crystal is diffused through the central group of the Grampian range. In one instance ten hundredweights were taken from one cavity. The crystals found on the east side of Loch Aven are of a light colour and very clear, whilst those found on the west side are of a dark brown." In fine crystals, with the form $\mathrm{P}\,z$ at Ballygroggan, Mull of Cantyre in cavities of trap rock.

Ireland.—Antrim; Knocklayd Mountain near Ballycastle. Colourless crystals at Divis Hill near Belfast. Near Carlow. In Donegal, very fine. Downshire; very beautifully crystallized with topaz and beryl, generally dark brown or black, in clefts and cavities of the Mourne Mountains' granite, with the forms $\mathrm{P}\,z\,b\,s\,f\,\phi\,v\,x$; $\mathrm{P}\,z\,b\,x\,\beta\,m\,\phi\,h$; $\mathrm{P}\,z\,b\,x\,s\,y\,f\,\beta\,\gamma\,h\,(\phi)$. Dublin Co.; at Howth, in marl. Yellow at Palmerston. Kerry; at Killarney, in detached crystals, yellow; in sandstone at Mullock Veil. Kilkenny; in large crystals at Castle Comer. Londonderry; parishes of Upper and Lower Cumber. Very fine at Dungiven, parish of Banagher. Also at Finglen Moun-

[illegible] localities it occurs in [illegible] smoky imbedded in [illegible] locally by the name of [illegible] weighing [illegible] In small [illegible] disposed in flat [illegible] beds in the [illegible] Co. Kerry. Ty- [illegible] in large detached [illegible]

[illegible] Wheal [illegible] and Wheal Tolgus [illegible] Wheal Cock, [illegible] Mills. [illegible] miles S.W. of St. [illegible] the Land's End in [illegible] finely cry- [illegible]

[illegible] Down.

[illegible] by lance- [illegible] sometimes project [illegible] and a half [illegible]

[illegible] S.W. of Ar- [illegible]

[illegible] bank of the [illegible] trans- [illegible] Meath; near [illegible] Kerry Head; [illegible]

In the Hebrides [illegible] Lewis and North Uist.

[illegible] *Common Quartz.*—Only a few localities can be named where this variety presents peculiarities in structure or colour, [illegible] *Rock-crystal*, crystallized and tain, close to Dungiven,—at all of which localities it occurs in large detached crystals, of a yellow colour or smoky, imbedded in the soil. Sometimes very perfect, known locally by the name of Dungiven crystals. One has been found at Dungiven weighing nearly 90lbs. At Rovenagh near Newton-Limivady. In small colourless crystals in drusy cavities, frequently disposed in flat columnar radiations, in the remarkable magnesian beds in the chalk at Donald's Hill. At Blasquet Island, Co. Kerry. Tyrone; parishes of Donaghmore and Tullyniskan in large detached crystals. Wicklow; yellow, at Glen Malur.

b. Amethyst.—Cornwall; Wheal Buller, and Wheal Tolgus near Redruth. Wheal Bellon near St. Just. Wheal Cock, Wheal Alfred. St. Cleer near Liskeard. Bos-averne Mills. Levant Mine, St. Just. St. Ewe parish, four miles S.W. of St. Austell. Nangisel Cove, Sannen, near the Land's End in drusy cavities. Wheal Uny near Redruth, lately, nicely crystallized. At Wheal Hope near Truro.

Devon; at Oakhampton. Radiated at Whitchurch Down.

Gloucestershire; at Clifton; very fine, penetrated by lance-like crystals of hydrous oxide of iron, which sometimes project half an inch; also at Providence iron-mine, one mile and a half S.W. of Clifton.

Somersetshire; parish of Cheddar, two miles S.W. of Axbridge, in nodules.

Ireland.—Cork; near Cork, at a quarry on right bank of the Lee, in very fine crystals. Mayo; Achill Island, in fine translucent crystals, occasionally 8 or 10 inches long. Meath; near Navan, of a pale colour. Also in Dublin Co.; at Kerry Head; in Leitrim.

In the Hebrides; in Lewis and North Uist.

c. Common Quartz.—Only a few localities can be named where this variety presents peculiarities in structure or colour, or is otherwise deserving of notice. *Reddish*; crystallized and massive at Wheal Bucketts, Cornwall. *Black, brown, and smoky.* Cornwall, at Carnbrae; Cleator Moor, Cumberland; Lindale Moor near Ulverston, N. Lancashire. Isle of Arran, Bute. Ben Lawers, near Loch Tay, Perthshire. In form of figure 2, with calcite, in greenstone, at Salisbury Craigs, Edinburgh. At Cairngorum S.W. of Banff. With felspar, in Isle of Skye. With felspar and topaz in granite of Mourne Mountains, Downshire. In Carlow. *Rose Quartz.* Aberdeenshire. On hills of Kildrummy, Auchindoir and Glenbucket. In fine specimens on the shores of Kirkaness, Shetlands. Opalescent and pink, Island of Shiant, Hebrides. Near Belfast. *Blue.* Cornwall; massive at Pednandrea mine, near Redruth, and at North Roskear. *Prase,* a leek-green massive variety, occurs in Cornwall at North Roskear, and at Wheal Bellon near St. Just. At Falcon Craig near Keswick, and in quartz veins in the Island of Bute. It is common quartz impregnated with amphibole. *Cat's-eye,* greenish-white to greenish-grey and olive-green, also red and brown, is quartz penetrated by parallel fibres of amianthus, which give it a peculiar opalescence when cut *en cabochon*; a pale-green variety occurs with epidote in the Vale of Llanberris, near Carnarvon; also in Scotland. *Avanturine,* yellow, red, grey or brown, is quartz spangled with numerous scales of mica, or traversed in every direction by numerous little clefts. According to Dr. M'Culloch, occurs at Glenfernat in Atholl, N. Perthshire, of a fine greyish-blue. *Fibrous Quartz.* Cornwall; at Wheal Virgin near Scorrier, and at Tolcarn four miles S.S.E. of Truro. Acicular, at Bangor slate quarries, N. Carnarvon. In small fibrous tufts on red Heulandite at Campsie Hills, S. Stirlingshire. At Holly Park near Rathfarnham, S. Dublin. Radiated quartz is not uncommon in Cornwall, especially in cross-courses, hence it is sometimes called by the miners cross-course spar. *Hacked Quartz,* very fine, lately at Herodsfoot mine near

Liskeard, Cornwall. *Cellular Quartz, Floatstone.* Cornwall; Relistian mine, four miles S.W. of Camborne; Cardrew mine, and at Pednandrea. Floatstone, or nectic quartz, a variety which floats in water till the air contained in its pores is expelled, at Wheal Alfred. A singular cellular or honey-comb variety, of a dark brownish-grey, has been met with at Alston, Cumberland; probably the skeleton of decomposed septaria. *Capped Quartz.* Occurred formerly in very interesting specimens, externally translucent, internally opaque, of a light brown colour, in Cornwall. *Globular Quartz.* At Knockmahon copper-mines near Bunmahon, S. Waterford; and of a black colour, in chalk, at Dover. *Stalactitic Quartz.* Wheal Alfred, Cornwall. At Clifton near Bristol. At the Giant's Causeway, Antrim, brown. *Sand.* The white variety is nearly pure silica, which forms the basis of all kinds of glass. The chief localities for sand suitable to the wants of the glass manufacturer are at Lynn, on the coast of Norfolk; Headon Hill, north side of Alum Bay, Isle of Wight, where it occurs in a bed from 30 to 50 feet thick; at Ard near Salt Lough, N. Donegal. *Flexible Quartz* occurs near Whitby, according to W. Phillips.

d. Ferruginous Quartz, or iron-flint, contains an admixture of red or yellow ochre, or Göthite; it is a variety consisting in part of distinct crystals, and partly of granular individuals. Red, yellow, or blackish-brown. It forms the transition to jasper. Occurs at Botallack and Marazion in Cornwall. With common quartz and hæmatite, at Clifton. In geodes, in new red sandstone, at Churchill. On Skiddaw, Cumberland. At Stocking Moor near Glasgow. In trap, at Dunbar, N.E. of Haddingtonshire. In minute crystals, of a yellow colour and massive, at Benbradagh Hill near Dungiven, Londonderry. In trap on Rathlin Island, N. Antrim.

e. Hornstone.—Massive, compact, but frequently pseudomorphous. Grey, or yellowish-brown. Fracture conchoidal and smooth, or flat and splintery. Glistening or dull. Translucent on the edges.

Occurs frequently in Cornwall and Devon, as at Herodsfoot mine near Liskeard, and at Beeralston and Beerferris. On Helvellyn. At the Menai Strait. At Dunbar, N.E. of Haddington. At Milltown, two miles south of Dublin.

f. Flinty-slate.—A close slaty variety; grey, reddish, yellowish, and occasionally black. The latter, which is indistinctly slaty, with a flat conchoidal fracture, is termed *Lydian-stone.* Flinty-slate forms entire formations. Lydian-stone, which is employed as a touch-stone, occurs at Leadhills; at the Braid and Moorfoot Hills near Edinburgh. At Glass Drummond, Downshire. Near Carlow.

g. Jasper.—This is, in part, compact ferruginous quartz, in part a compact variety of quartz coloured red by hæmatite, or yellow and brown by Göthite. Fracture conchoidal; dull, opaque. Among the varieties may be cited common jasper, ribbon-jasper, and agate-jasper. Dull-red, yellow, brown, green, or mottled. What is called *porcelain-jasper* is only baked clay. It is distinguishable from true jasper by its fusibility on the edges before the blowpipe. Jasper of various colours occurs in Cornwall, as at Botallack, Cape Cornwall, Wheal Sparnon, Wheal Maudlin, Wheal Unity, and at Tregos, four miles S.E. of St. Columb Major. Devonshire; at Ivy Bridge. Dorset; Isle of Portland. At Falcon Craig, Cumberland. Yorkshire; at Scarborough, and near York. Very fine ribbon-jasper occurs at Dressing Green near Tortworth, Gloucestershire. In Scotland it is common, as at Dunglass, S. Dumbarton; Kilsyth, Campsie, and Killearn, Stirlingshire. Habbies Howe, Pentlands; Arthur's Seat, Edinburgh. Isles of Islay and of Rum, Argyll. *Ribbon-jasper* is found at Ballygroggan, Mull of Cantyre.

Ireland.—Antrim; abundant in the Cushendell porphyry.

Also in the older conglomerate of Tyrone. At Lough Erne Head, Fermanagh. Of a deep red colour at Slieve Gallion, Londonderry. In Wicklow.

Porcelain-jasper, as it is called, is met with in Madeley parish, two miles N.E. of Broseley, E. Salop.

Between quartz and opal certain minerals are to be intercalated, which, according to Fuchs, may be looked upon as intimate mixtures of amorphous and crystalline silica, and from which the amorphous silica, or in other words, the opaline portion, may be extracted by a solution of caustic potash. Among such minerals chalcedony and flint occupy a prominent place.

h. Chalcedony.—Reniform, botryoidal, stalactitic, dendritic and pseudomorphous. Fracture even to flat conchoidal and fine splintery. White and light grey, bluish, also yellow-brown and red. Occasionally striped or streaky. Pellucid to opaque; dull or semi-lustrous on the surface of fracture. There are several sub-varieties of chalcedony, of which the following occur in the United Kingdom:—

a. Common Chalcedony.—Cornwall; Trevascus mine formerly produced most beautiful specimens in dendritic, arborescent and stalactitic forms, with a pearly yellowish-grey enamel. Very fine at Ponsanooth and North Pool mines. Smalt-blue at Pednandrea. At Botallack. Formerly at Wheal Alfred. Blue and *hydrophanous* at Wheal Maudlin, Liskeard. Devonshire; at Haytor iron-mine and near Sidmouth. At Charmouth, Dorset. Cumberland; at Roughtengill, Silvergill, and at Caldbeck Fells. At Undercliffe, Isle of Wight. At Whitby, Yorkshire.

Grey, with pitchstone, Isle of Rum, Argyll. Orkneys; in Waas, Hoy. At Allan Bank, East Berwick. Edinburgh; fossil wood as chalcedony at Craig-Leith quarry near Edinburgh. At the Pentland Hills. Fifeshire; on the coast near Kinghorn, reniform, of a bright red, in trap.

Antrim; white and hydrophanous near Giant's Causeway. Shores of Lough Neagh, (also Armagh, Tyrone and Londonderry). At Cloghan, Donegal. At Lambay, Dublin Co. Londonderry; parish of Balteagh. Mammillated and on pearl-spar, at the junction of the trap and chalk, at Smulgedon near Dungiven, at the White Mountain and Slieve Gallion.

b. Onyx is the name given to chalcedony in alternate layers of black and white. In Skye, frequently forming the bottom of neolitic druses. In Perthshire. In Antrim, at the Causeway in amygdaloid, and on Rathlin Island; also on shore of Lough Neagh.

c. Sard is chalcedony in alternate layers of brown, red and white.

d. Sardonyx, alternate layers of sard and onyx. This and the above occur in Perthshire.

e. Carnelian is red, yellow or brown chalcedony. Carrock Fells and Falcon Craig, Cumberland. On the beach near Scarborough; similarly at many places on the south coast of England, as Chesil Bank, S. Dorset; Sandown Bay, Isle of Wight; on the beach at Peel Bay, Isle of Man; coast of Flintshire, and at several of the localities where the following sub-variety is met with.

f. Agate.—This is a mixture, generally in alternating irregular layers, of chalcedony, jasper, amethyst, and other varieties of quartz, and according to the character of its markings is called fortification-, moss-, ribbon-, coralline-agate, and so forth.

Cornwall; in quartzose rock on S.E. part of Carnbrae Hill; in serpentine at Kynance Cove, or the Devil's Bellows, one mile N.W. of the Lizard Point. At Carrock Fells and Falcon Craig, Cumberland. In trap at Mickleton, Gloucestershire. In gravel near Lichfield, Staffordshire.

In Scotland agates are commonly called Scotch pebbles. They occur, among other places, at Jedburgh, Roxburgh. At Carlops, Pentland Hills, Peebleshire. At Dunure, and along the coast, Ayrshire. Habbies Howe, Edinburgh. In the rocks near Montrose, Forfar. At Dunbar, and very fine, red and mottled, at Dunglass, Haddington. Near Stonehaven, Kincardineshire. Very fine, at Kinnoul Hill near Perth, and in the bed of the Tay thereabouts. Fife near Kinross. Dunnegan Head, Isle of Skye, grey, sometimes hollow.

Ireland.—Antrim; coast near Ballycastle and shores of Lough Neagh. Donegal; near Malin Head at the entrance into Lough Swilly, and also at Clonca, on the coast. Red agate occurs in Wicklow.

Scotch pebbles, which often consist of irregular layers more or less porous, are frequently boiled in oil and then in sulphuric acid, by the lapidary. The oil imbibed by the fibrous or porous portions of the stone becomes carbonized by the action of the acid, whereby they, to a certain extent, assume an onyx-like appearance. Agates may be stained yellow by treating them with carbonate of soda at a high temperature.

g. Jasper-agate occurs at Dunglass, Haddington. Very fine at Burn Anne near Galstone, Ayrshire. In amygdaloid in Donegal; at Lambay, Co. of Dublin; at Bray Head in Wicklow.

h. Heliotrope is a mixture of chalcedony and earthy chlorite, studded often with red spots. In the Isle of Rum, and Mull of Cantyre, Argyleshire.

i. Mocha-stone is white chalcedony with moss-like brown markings; it is met with in Wicklow.

Flint is a variety of chalcedony in nodules and small beds in the upper chalk. Easily broken; cleavage flat conchoidal with sharp edges; greyish-white to smoke-grey, and black, yellowish-white, yellowish-grey, to brown. Resinous to dull. Translucent in various degrees. Encloses Sponges, Alcyonia, Echinites and other fossils; is found in the chalk formation of England and the north of Ireland. In Scotland rare; one locality is on the shore by Burntisland, S.W. of Fife. Capital specimens of common quartz occur in the "Caller" flint nodules in chalk-pits near Canterbury in Kent.

LOCALITIES of *pseudomorphous* quartz, hornstone, and chalcedony.

Quartz.—Pseudomorphous. Cornwall. Cubic or octahedral, in the form of fluor, Wheal Alfred; at Carnbrae; Balleswidden, St. Just; at Wheal Spearn, St. Ives. Wheal Sparnon near Redruth; North Roskear, Camborne. In fine specimens, lately, at Trehane, Menheniot; at Great Crinnis; at Wheal Herland near Hayle; at Perranzabuloe. Octahedral at Holmbush mine, Callington; also at S. Caradon, St. Cleer.

In the form of calcite at the Gwennap mines; in tabular crystals after the same at Botallack, and lately at Consolidated mines near St. Ives.

As pearl-spar, Levant mine, near St. Just.

Devon; cubic or octahedral, Beeralston and Beerferris. South Hoo mine. After calcite, formerly at Haytor iron-mine.

Cumberland; capping fluor, at Alston and Nenthead; similarly at Allenheads and Wheal Allendale, Northumberland, and Weardale, Durham.

Gloucestershire; near Bristol, in sandstone, as small cubic crystals, after fluor.

Salop; in hollow cubes, after galena or fluor, at Bog mine.

Dumbarton; as stilbite*?, at Kilpatrick. As pearl-spar, at Hoy, Orkneys.

Hornstone is common at Beeralston, in the form of octahedral fluor, or capping it.

Chalcedony.—Cornwall; after calcite, in rhomboids and six-sided plates, near Penzance and St. Just. As pearl-spar, and also coating it, at St. Just, lately, and also at North Roskear. In the form of tabular crystals of barytes, lately, in fine specimens, at Herodsfoot near Liskeard, and at Wheal Mary.

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* See Weissigite.

Devon; after calcite, very beautifully, at Haytor iron-mine, also at the same place in the form of datholite, a variety known as Haytorite; this variety has also recently occurred at North Roskear mine in small crystals, and showing a new face β (see Datholite), not before observed.

Fulgurites, or vitrified sand-tubes, produced by the action of lightning, occur occasionally in the sand and sand-hills on the coast of Cumberland and Lancashire. They have recently been formed in tubes an inch long at Paris, by means of the discharge of a powerful electric battery.

Kilpatrick-Quartz of Thomson, occurs in the amygdaloid of the Kilpatrick Hills near Dumbarton, in small spherical masses, white and translucent, consisting of fibrous and radiated crystals terminated at their outer extremities; lately it has been found frequently associated or mixed with stilbite, natrolite, and other zeolites, of a pale flesh-red colour, and fibro-massive.

It is evidently quartz; the 3 per cent. of water given in Thomson's analysis, in all probability arose, according to Heddle, from intermixture with minute radiating crystals of natrolite of a pinkish colour.

44. OPAL.—Hyalite.

Amorphous. Fracture conchoidal. Translucent. Lustre vitreous to resinous. Colourless, white, yellow, brown, green-grey, black. Some varieties exhibit a rich play of colours. Brittle. H. 5·5 to 6·5; Gr. 1·9 to 2·3.

In the matrass yields more or less water. Before the blowpipe decrepitates, and is infusible; nearly quite soluble in a cold solution of caustic potash; in other respects the chemical characteristics are the same as those of quartz.

Consists of amorphous quartz, with from 3 to 13 per cent. of water, and small quantities of iron, alumina, magnesia, potash, lime and soda.

Analyses: *a*, fire-opal, from Mexico, by Klaproth; *b*, hyalite, from Bohemia, by Damour:—

	a.	*b.*
Silica	92·00	96·94
Peroxide of iron	0·25	...
Water	7·75	3·06
	100·00	100·00

The variety called *hyalite* is transparent or semi-transparent, reniform or botryoidal, and as hard as quartz; *fire-opal* is semi-transparent, red, yellow, sometimes iridescent; *noble opal*, translucent and opalescent; *common opal* shows no play of colours; *semi-opal* is dull and opaque; *cacholong* is white and opaque; *siliceous sinter* is deposited in fibrous, reniform and botryoidal masses from hot springs; *hydrophane* imbibes water readily, and becomes more transparent in consequence.

Common opal; occurs in Cornwall, of a white or leek-green colour in very characteristic specimens at several of the following mines:—Huels Stennach and Spinster near St. Day; at Roskear and Huel Rosewarne in Camborne; at Huels Poligine, Buller and Damsel; at Botallack mine, St. Just. In the island of Rum.

Ireland.—In Antrim; at the Causeway, in Rathlin Island, at Crossreagh in the parish of Ballywillin, and at several places along the basaltic range of the N.E. coast of Ireland, usually white, sometimes yellowish and opaque; at Sandy Braes, in pitchstone porphyry of different colours, and sometimes slightly opalescent.

Semi-opal; occurs near Redruth, as at Huel Buller; near St. Ives and St. Just; and at Oakhampton, near Dartmoor in Devon.

Fire-opal; at Huel Spinster, at Rosewarne copper-mine, at Huel Gorland formerly; lately near St. Just, of a light colour and semi-transparent.

Cacholong; in Ulster, at Smulgedon; in Tyrone Co. in felspathic porphyry in the parish of Cloger, and similarly at Barrack mountain in the parish of Pomeroy.

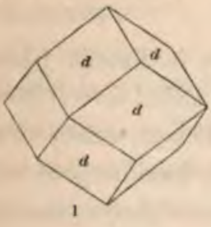
Hydrophane; in small roundish masses in amygdaloid, of a brownish-white colour, near the Giant's Causeway, and at Crossreagh, parish of Ballywillin.

Jasper opal occurs at Sandy Braes in Antrim, and in some parts of the west of Scotland. *Ferruginous opal*, at St. Just in Cornwall, and near Camborne.

Hyalite; Co. Down; occurs in well-defined specimens at Donald's Hill, forming a mammillated coating of concentric layers in the cavities of a soft claystone amygdaloid, and occasionally studded with small crystals of Arragonite; occasionally coating granite as a thin mammillated crust, white, translucent and pearly; and also pearly and iridescent at Quarus, south of Newcastle.

45. GARNET, *Phillips*; Grenat, *Hauy*. Pyrope. Cinnamon-stone.

Cubic. Dodecahedral. Cleavage with difficulty parallel to *d*. Fracture conchoidal, uneven. Transparent, translucent, opaque. Lustre vitreous inclining to resinous. Colour red, brown, yellow, green, black. H. 6·5 to 7·5; Gr. 3·1 to 4·3.



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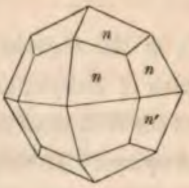

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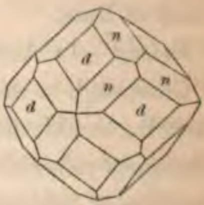

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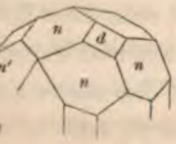

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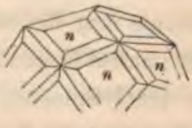


4

d d 120° 00′ *n n* 146° 27′ *n n′* 131° 48′ *d n* 150° 00

British forms: *d*; *n*; *dn*; and figure 4, (?) *ns*; *sn*=169·06.

Before the blowpipe melts readily into a glass, which is more or less dark in proportion to the amount of iron present.

Imperfectly soluble in muriatic acid, but more readily after fusion, leaving a jelly of silica.

General formula, $\dot{\mathrm{R}}^3\dddot{\mathrm{Si}}+\dddot{\bar{\mathrm{R}}}\dddot{\mathrm{Si}}=(\frac{1}{2}\dot{\mathrm{R}}^3+\frac{1}{2}\dddot{\bar{\mathrm{R}}})\dddot{\mathrm{Si}}$: the proportions of lime and alumina vary very much in different garnets, as well as those of the peroxide and protoxide of iron.

Analyses: *a*, from Ceylon, by Gmelin; *b*, from Wicklow (*black*), by Mallet; *c*, from Killiney (*brown*), also by Mallet; *d*, from Willsborough, by Seybert; *e*, from Haddam, Connecticut, by Seybert:—

	a.	*b.*	*c.*	*d.*	*e.*
Silica	40·01	35·77	37·80	38·00	35·83
Alumina	23·00	19·85	21·13	6·00	18·06
Red oxide of iron .	3·67	...	...	28·06	...
Lime	30·57	...	1·53	29·00	...
Magnesia	...	...	4·46	...	...
Protoxide of iron . .	...	38·07	38·43	...	14·93
Protoxide of manganese	...	5·04	...	...	30·96
	97·25	98·73	99·75	101·06	99·78

Formula of *a* is $\dot{\mathrm{Ca}}^3\dddot{\mathrm{Si}}+\dddot{\bar{\mathrm{Al}}}\dddot{\mathrm{Si}}$; with silica, 40·31; alumina, 22·41; lime, 37·28, this being a *lime garnet*: of *b* and *c*, $\dot{\mathrm{Fe}}^3\dddot{\mathrm{Si}}+\dddot{\bar{\mathrm{Al}}}\dddot{\mathrm{Si}}$; with silica, 37·08; alumina, 20·62; protoxide of iron, 42·30, or an *iron garnet*: of *d*, $\dot{\mathrm{Ca}}^3\dddot{\mathrm{Si}}+\dddot{\bar{\mathrm{Fe}}}\dddot{\mathrm{Si}}$; with silica, 36·08; peroxide of iron, 30·56; lime, 33·36, or an *iron-lime garnet*. There are also *magnesia-*, $\dot{\mathrm{Mg}}^3\dddot{\mathrm{Si}}+\dddot{\bar{\mathrm{Al}}}\dddot{\mathrm{Si}}$, *manganese-*, $\dot{\mathrm{Mn}}^3\dddot{\mathrm{Si}}+\dddot{\bar{\mathrm{Al}}}\dddot{\mathrm{Si}}$, and *chrome-*, $\dot{\mathrm{Ca}}^3\dddot{\mathrm{Si}}+(\dddot{\bar{\mathrm{Cr}}}\dddot{\bar{\mathrm{Al}}})\dddot{\mathrm{Si}}$, *garnets*; the latter at least not yet found in Britain.

Garnet occurs in attached and imbedded crystals, granular and massive; most commonly in granite, mica-slate, dolomite, chlorite slate and lava.

Pyrope is a variety of precious garnet, of a deep red colour, which on heating becomes black, and is said to contain some

38765

oxide of chrome: *almandine* is a general term applied to the precious or transparent varieties. The *Jellelite* of Apjohn, from Ireland, containing $\dddot{\mathrm{Si}}$, 38·09; $\dddot{\bar{\mathrm{F}}}\mathrm{e}$, 33·41; $\dot{\mathrm{C}}\mathrm{a}$, 28·61, is merely a garnet.

LOCALITIES.—*England.* Cornwall; in twenty-four-sided crystals at the foot of Chycornish Carn, one quarter of a mile south of Botallack, and at Roscommon Cliffs; in well-defined crystals near St. Just; near Camborne, with form of figure 2; at Le Morna Cove, and with copper-ore at Traunock near Helstone.

Devonshire; near Dartmoor.

Cumberland; of a brown colour, both crystallized and massive, at Saddleback; in very perfect crystals in a flinty slate near Keswick. In the County of Durham occasionally.

Westmoreland; at Willow Crag.

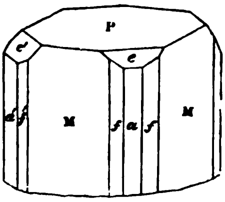
Scotland.—Aberdeenshire; at the limestone quarries at Glen Gairn, of a cinnamon colour; at Ardonald, between Keith and Huntly, in clay-slate; in the parish of Glass near Huntly; in conglomerate at Huntly, with the forms *d*, *n*, *d n*, *n s*, dark red colour and translucent; at Gaingomers, Hill of Maluth, four miles N.W. of Huntly; at Rubislaw granite quarries near Aberdeen; at Glenbucket in mica-slate, parish of Towie. Argyleshire; at the top of Ben Risipol near Strontian, and at Strontian in large crystals; at Tyrie, in flesh-coloured marble. Banffshire; at Portsoy and at Knock Hill. Fife; near Ely (*pyrope*) in transparent crystals, fit for purposes of jewelry. Perthshire; in mica-schist at Blair-Athol, at Balichan, and at many other places in mica-slate. In the island of Mull in large crystals. Shetlands; in Mainland in mica-slate, as at Hillswickness, both common and precious; in the island of Unst. Common in the granites of Ross-shire. In the island of Harris; Hebrides in gneiss.

Ireland.—Co. Dublin; at Dalkey in granite; in small red and brilliant crystals with spodumene at Killiney Hill. Donegal;

in talcose mica-slate in the parish of Templecarn; at Barnes Gap near Kilmacrenen; in large dodecahedral crystals of a rich cinnamon colour, and also in dark green crystals very large and perfect, and accompanied with idocrase, in a coarse crystalline dolomite at Bum Beg near Gweedore; at Annagary Hill near the police barracks. Wicklow; near Roundwood in Glen Malur; crystallized and of a cinnamon colour at Kilranelagh, and in the auriferous streams.

46. IDOCRASE, *Phillips, Hauy*. Vesuvian.

Pyramidal. Cleavage M, *a*, not very distinct, P less so. Primary form a right rhombic prism. The faces M, *a*, *f*, *h* usually striated parallel to their intersections with each other. Fracture imperfect, conchoidal, uneven. Translucent. Lustre vitreo-resinous. Colour various shades of brown and green, olive, sometimes yellowish or black. Slightly dichroitic. H. 6·5; Gr. 3·35 to 3·45.



M M	90° 00′	*h a*	161° 34′
M P	90 00	P *g*	133 03
M *a*	135 00	P *u*	142 53
f a	153 34	*e e′*	141 01
P *e*	151 50	*u u*	129 29

Combinations: M *a* P, Glen Gairn; M *a* P *f e*, and perhaps M *a* P *h e u g*, both from near Gweedore in Donegal. *h* cuts *a f*.

Before the blowpipe melts with intumescence into a yellowish-green or brown glass. With borax fuses into a glass coloured with iron. But slightly acted on by acids; after fusion completely decomposed, leaving a jelly of silica.

Analyses: *a*, from Egg, Norway; *b*, from Vesuvius, both by Magnus; *c*, from Piedmont, by Karsten; *d*, from near Königsberg, by Rammelsberg; *e*, from Wilui, Siberia, by Hermann:—

	a.	*b.*	*c.*	*d.*	*e.*
Silica . . .	37·66	37·36	39·25	37·24	38·23
Alumina . .	17·70	23·53	18·10	16·80	14·32
Red oxide iron	...	...	...	7·21	5·34
Protox. of iron	6·49	3·99	4·30	...	1·03
Lime . . .	31·90	29·68	33·85	33·60	34·20
Magnesia . .	4·54	5·21	2·70	5·26	6·37
Protox. mang.	0·50		0·10	...	0·50
Loss by ignition	...	...	...	0·22	$(\ddot{C})$
	98·79	99·77	98·30	100·33	99·99

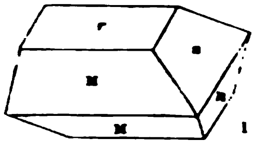
Formula, $\dot{R}\dddot{Si}+\ddot{\bar{R}}\dddot{Si}$; with silica, 39·6; alumina, 22·5; lime, 32·6; protoxide of iron, 5·3. Sometimes $3\dot{R}^3\dddot{Si}+2\ddot{\bar{R}}\dddot{Si}$, which gives silica, 38·4; alumina, 17·4; lime, 38·0; protoxide of iron, 6·2.

Localities.—Aberdeenshire; at the limestone quarries in Glen Gairn, combinations M *a* P and M *a* P *f*; and on the Guwn River. Skye; one mile and a half south from Broadford on the way to Kilbride.

Ireland.—Donegal; in greenish-white limestone, in striated and aggregated prisms of a hair-brown colour, at Derryloaghan; at Barnes Gap near Kilmacrenan; near Lettermacherward; at Bumbeg near Gweedore, in crystalline dolomite, presenting occasionally tolerably distinct crystals of a hair-brown colour, accompanied with fine crystals of garnet.

47. EPIDOTE.—Epidote, *Brooke* and *Miller*, *Phillips*, *Hauy*; Epidot, *Hausmann*, *Haidinger*. Withamite.

Oblique. Primary form an oblique rhombic prism. Cleavage M perfect and brilliant, T less perfect, *l* often striated. Colour green of various shades, from pistachio-green to olive-green, yellow, brown, red. Lustre vitreous; pearly on the faces of perfect cleavage (Naumann says, approaching to adamantine). Semi-transparent to translucent on the edges. Exhibits pleochroism. Brittle. Fracture conchoidal to uneven, and splintery. H. 6 to 7; Gr. 3·2 to 3·5.



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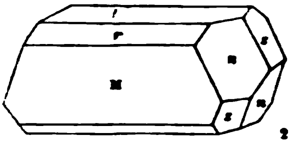

2

M T	115°	24′
M *r*	116	17
T *z*	125	04
M *l*	90	33
M *n*	104	49
M *z*	104	16
r *n*	125	16
z *z*	109	51

Before the blowpipe, the behaviour of epidote from different localities varies; all varieties, however, after ignition or fusion are decomposed more or less readily by hydrochloric acid, with the formation of a jelly of silica.

The green varieties before the blowpipe first melt on the extreme edges, and then swell up to a dark-brown mass, which cannot be brought to a state of complete fusion. The glass shows decided reaction of iron. The brownish and blackish-red varieties melt readily before the blowpipe to a black glass, and with borax give the reaction of manganese.

Analyses of epidote: *a*, from Bourg d'Oisans; *b*, from Arendal, both by Rammelsberg; *c*, from St. Gotthardt, by Scheerer:—

	a.	*b.*	*c.*
Silica	38·37	37·98	37·35
Alumina	21·13	20·78	22·02
Peroxide of iron .	16·85	17·24	15·67
Lime	23·58	23·74	22·54
Magnesia . . .	0·17	1·11	(2·35 $\dot{H}$)
	100·10	100·85	99·93

$\dot{C}a^3\ddot{S}i + 2(\ddot{A}l^{\frac{2}{3}}\ddot{F}e^{\frac{1}{3}})\dddot{S}i$; with silica, 39·16; alumina, 20·84; peroxide of iron, 16·26; lime, 23·74, the alumina being to the iron as 2 : 1. Manganesian epidote is $\dot{C}a^3\ddot{S}i + 3(\ddot{A}l\,\ddot{M}n\,\ddot{F}e)\dddot{S}i$.

Occurs in granite, trap, and various crystalline slate-rocks, in detached and acicular crystals, granular and massive.

Localities.—*England.* Cornwall; with pyrites, St. Just. At Carn Silver. At Lemorna Cove at the junction of the granite and clay-slate; at the Crown Rock, Botallack, St. Just. Marazion, in quartz.

Cumberland; fibrous and crystallized on Skiddaw, at Willow and Falcon Craigs, all near Keswick. At Crossthwaite.

Worcestershire; on the Malvern Hills.

In Jersey, crystallized, in granite. In Guernsey, with felspar, in granite.

Wales.—In the Vale of Llanberris, in cat's-eye quartz, acicular and diverging, of an olive-green. Merionethshire; at Dolgelly with calc-spar in elvans.

Scotland.—Aberdeenshire; at Stonehaven Bay, in acicular crystals in conglomerate rock. Inverness-shire; at Glenelg, crystallized and in lamellar and radiating masses of a pale green. Argyleshire; at Glenco, in trap, the variety called *Withamite* is met with in minute crystals of the form of figure 1. It occurs also massive. The crystals are of a brilliant red and transparent, radiating from a centre, or lining small cavities in the rock, a trap in which they are as it were caught. These crystals are red and yellow, respectively, in two directions at right angles to each other. Bute; Isle of Arran, in the form of figure 2. In Iona, in clinkstone. In Skye, in trap. In Island of Mull, in acicular crystals in amygdaloid, along with zeolites; Killimore, Loch Seriden.

Ireland.—Near Galway, in trap. In greenstone at Knockmahon mines, Waterford. At Barnes Gap, Kilmacrenan, Donegal, of a light green. In small acicular crystals, and also in thin strings and veins, in the syenitic rocks of Slieve Gallion and Kildress, Co. Derry. In veins at Fair Head, Antrim, with quartz, fluor and pink felspar. Granular and forming veins in the hornblendic rocks at Termontownland, parish of Termonmaguirk, and similarly at Tieverah Mountain. A fibrous stellated variety occurs near Rosstrevor, Co. Down, to which the name *Rosstrevorite* has been applied.

The name epidote is derived from ἐπίδοσις, *addition*.

48. ZOIZITE, *Werner*; Epidote (in part), *Dana, Rammelsberg*.

Oblique; according to Brooke, has nearly the same form and angles as euclase; one perfect lateral cleavage*. Lustre vitreous. Colour greyish-white, yellowish-grey, brown and light green. Seldom with terminal planes. Gr. 3·28 to 3·35.

Before the blowpipe *per se* intumesces and fuses without difficulty into a slightly translucent, greenish-white irregular mass. With borax in the outer flame fuses slowly into a transparent glass, of a pale yellow colour, colourless when cold.

Analyses of specimens from the Saualp in Carinthia, crystallized: *a*, by Klaproth; *b*, by Rammelsberg:—

	a.	*b.*
Silica	45·0	41·51
Alumina	29·0	28·90
Peroxide of iron .	3·0	3·98
Lime	21·0	24·78
Magnesia . . .	...	0·58
	98·0	99·75

Formula, $2\dot{\text{Ca}}^3\dddot{\text{Si}}+5(\dddot{\text{Al}}\dddot{\text{Fe}})\dddot{\text{Si}}$; with silica, 43·2; alumina, 36·8; lime, 20·0, the alumina partially replaced by oxide of iron. Perhaps $\dot{\text{Ca}}^3\dddot{\text{Si}}+2\dddot{\text{Al}}\dddot{\text{Si}}$, or nearly epidote.

This mineral used to be confounded with epidote, of which it was considered a pale-coloured variety. Mr. Brooke supposed its crystalline form to be a distinct one, the plane of principal cleavage being at right angles to that of the plane M in epidote.

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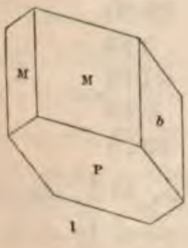
* Prof. Dana has more recently shown that zoizite is really identical with epidote, and that Mr. Brooke was probably mistaken: see Silliman's Journal, vol. xxiv. July 1857.

Jameson's *zoizite* from Glenelg in Inverness-shire, is only epidote. It is said to occur in fine crystals of a greyish-brown or olive-colour at Hollyhill near Strabane, Co. Tyrone.

49. **FELSPAR.**—Felspar, *Brooke* and *Miller*, *Phillips*; Orthoclase, *Dana*; Feldspath, in part, *Hauy*; Feldspath, *Hausmann*; Adular, *Haidinger*; Orthoklas, *v. Kobell*, *Naumann*. Erythrite. Murchisonite. Rhyacolite. Variolite.

Oblique. Primary form an oblique rhombic prism. Frequently twinned. Twin faces P, *n*, *z*. Cleavage P very perfect; *b* sometimes tolerably perfect; M difficult to obtain; M, *b*, *z* striated parallel to their intersections with each other. Fracture conchoidal to uneven, and splintery. Colourless, but more usually coloured, especially reddish-white to flesh- and tile-red; also yellowish and greyish-white. Streak greyish-white. Lustre vitreous, on the basic cleavage frequently pearly. Sometimes opalescent (*Murchisonite*). Transparent to translucent on the edges. H. 6; Gr. 2·53 to 2·58. Gr. of rhyacolite said to range from 2·57 to 2·62.



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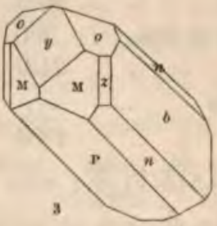

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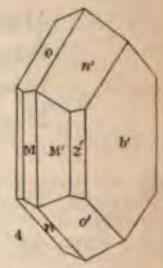

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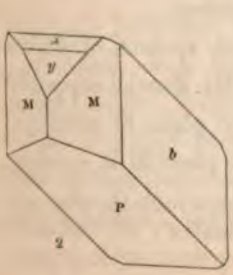

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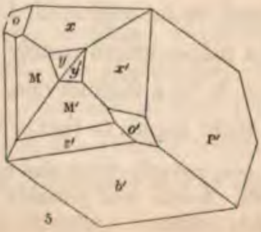

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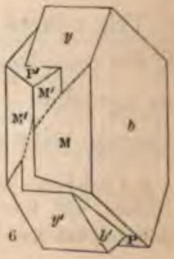

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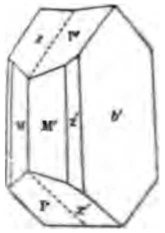

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M M	118°	54′	M y	134°	19′	b z	150°	35′
M P	112	16	P b	90	00	o b	116	53
M b	120	36	P′ x	129	41	o y	140	33
M n	95	14	P′ y	99	38	o z	124	59
M x	110	40	b n	134	57			

Combinations: M P *b*; M P *b y*; M P *b x y*; M P *b n o x y z*; M P *b n o y z*. **Twins**: M P *b y*; M P *b o x y*; M P *b x z*; M *b n o z*; M P *b o y*.

Melts with difficulty before the blowpipe into an opaque blebby glass. The variety rhyacolite fuses somewhat easier than ordinary felspar, the flame being tinged yellow. Soluble in salt of phosphorus, leaving a silica skeleton. With solution of cobalt becomes blue upon the fused edges.

Analyses of felspar: *a*, transparent colourless variety (*adularia*), from St. Gotthardt; *b*, from Baveno, both by Abich; *c*, flesh-coloured (*erythrite*), by Thomson; *d*, opalescent, from Dawlish (*Murchisonite*), by R. Phillips; *e*, *rhyacolite*, from the Lake of Laach; *f*, *variolite*, from Wicklow, by Galbraith; *g*, felspathic portion, from Savoy, by Durance:—

	a.	*b.*	*c.*	*d.*	*e.*	*f.*	*g.*
Silica . .	65·69	65·72	67·90	68·6	50·31	64·59	56·12
Alumina .	17·97	18·57	18·00	16·6	29·44	18·31	17·40
Peroxide iron	...	...	2·70	...	0·28	...	7·79
Potash . .	13·99	14·02	7·50	14·8	5·92	12·23	0·24
Soda . .	1·01	1·25	...	...	10·56	2·75	3·72
Lime . .	1·34	0·34	1·00	...	1·07	0·25	8·74
Magnesia .	...	0·10	3·25	...	0·23	0·60	3·41
	100·00	100·00	100·35	100·0	97·81	98·89	$\dddot{Cr}$ 0·51
							Ħ 1·93
							99·86

$\dot{K}\ddot{Si}+\dddot{Al}\ddot{Si}^3$; this is the formula for normal felspar; silica, 65·4; alumina, 18·0; potash, 16·6: part of the potash is frequently replaced by soda and lime. For rhyacolite the formula, upon the supposition that its composition is that of a Labrador rich in soda, would be $\dot{R}\dddot{Si}+\ddot{\bar{Al}}\dddot{Si}$; which requires silica, 51·86; alumina, 28·66, and $\dot{R}(=\frac{8}{12}\dot{Na}+\frac{3}{12}\dot{K}+\frac{1}{12}\dot{Ca})$=soda, 11·6; potash, 6·58; lime, 1·3, agreeing very closely with the analysis by G. Rose, given above under *e*. As he says, however, in his 'Mineralsystem,' that he suspects some nepheline may have been mixed with the rhyacolite which he operated upon, he no longer enumerates rhyacolite as a distinct species.

In attached and imbedded crystals; in crystalline and granular masses. Felspar is liable to suffer decomposition, forming a silicate of potash, $\dot{K}^3\dddot{Si}^8$, soluble in water, which is washed away, leaving a hydrous silicate of alumina, $\ddot{\bar{Al}}^3\dddot{Si}^4+6\dot{\bar{H}}$, porcelain-clay or kaolin. It is sometimes converted into a substance like steatite. Difference of colour and lustre has given rise to distinct names for several varieties of this species, among which adularia, erythrite, Murchisonite, rhyacolite, and variolite will be alluded to in the list of localities. Murchisonite is remarkable not only for its opalescence, already mentioned, but also for possessing a third cleavage in addition to the two at right angles to each other. It is upon this third cleavage-plane that the opalescent play of light is observable.

LOCALITIES.—*England.* Cornwall; *adularia* occurs at Tintagel in slate. Good crystals of common felspar are met with in green talc at the Old Lizard Head; in slate-rocks near Wheal Castle, St. Just; at Botallack; in granite near the Land's End, in large perfect crystals, often of an opaque white colour; in the neighbourhood of Penzance; St. Michael's Mount; Mulora Hill near Sancreed, and in the pinite-bearing granite of St. Agnes. The forms met with are represented in figures 3, 4, 6 and 7. At Wheal Coates near St. Agnes, crystals of felspar of the twin forms, figures 2, 4, 5 and 6, have been found converted into cassiterite. These interesting pseudomorphs occurred in considerable abundance; in some cases the conversion was complete, in others more or less of the original crystal of felspar remained unaltered. At this locality the crystals of felspar are also sometimes found converted into a substance like steatite.

Devonshire; *Murchisonite*, a flesh-red variety occurs in rolled pebbles at Dawlish and at Heavitree near Exeter. Some of the crystals are twins.

Cumberland; good crystals at Brandygill.

Westmoreland; at Shapfells.

Worcestershire; on the Malvern Hills.

Yorkshire; opalescent, in rolled pebbles, on the beach at Scarborough.

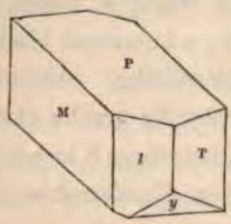
Wales.—Carnarvonshire; *adularia*, with quartz, on Snowdon.

Scotland.—Argyll; *rhyacolite*, in Island of Rum in pitchstone. Banffshire; in granite at Portsoy. Bute; Arran, *adularia*; also in Arran, in claystone porphyry, at Drumidoon or Drimadoon, in small opaque white crystals of the form of figure 3. Dumbartonshire; the *erythrite* of Thomson, a flesh-coloured felspar with 3 per cent. of magnesia, occurs in amygdaloid near Kilpatrick. Edinburghshire; what has been called a variety of felspar, and known by the name of *petuntze*, though in truth a quartzose felspathic rock, consisting largely of quartz, occurs of a greyish-red at the Pentland Hills; a brown and black mottled sort at Habbies Howe on the Peebles border. Shetlands; good crystals of common felspar in porphyritic granite at Skaw and Lambaness. In large red crystals, sometimes 8 inches in length and finely crystallized, at Rubieslaw, Aberdeenshire; and with rock-crystal on the Cairngorm Mountains.

Ireland.—Antrim; *variolite*, a greenish to dark-green rock containing disseminated spherules white or greenish-white, having the nature of felspar (analysis *f*), has been found in this county. *Rhyacolite*, common in trachytic porphyry, usually in distinct crystals, as in Antrim. Down; *adularia*, Mourne Mountains, at Slieve Corra; the forms of the St. Gotthardt twin-crystals occur here; at the same locality beautiful opaque white crystals, with the forms of figures 1, 2 and 5, with crystals of smoky quartz, albite, and topaz; also at Binion Hill, and near Lord. Dublin; opalescent, milk-white, and highly translucent, suitable for ornamental purposes, at Killiney; also at same place, and at Leopards-town, in very large white crystals in granite, associated with Killinite; at Dalkey, crystallized. Wicklow; at Lough Bray, at Lugganure, and at Seven Churches.

50. LABRADORITE.—Labrador Felspar, *Phillips*; Silicite, *Thomson*.

Anorthic. Primitive form a doubly oblique rhombic prism. Frequently twinned like albite; twin-face M. Cleavage perfect parallel to P, less so to M. Fracture imperfect, conchoidal, uneven, splintery. Faintly translucent. Lustre vitreous, inclining to pearly on the faces of most perfect cleavage, and pearly on the surfaces of the fracture. Colour grey, passing into yellow, red, green, white. The colours of the face M changeable. Streak white. Brittle. H. 6·0; Gr. 2·7.



M P	93° 35′
P *l*	114 26
M *l*	120 40

Before the blowpipe, on charcoal, behaves like felspar, and fuses to a colourless glass. When in powder entirely dissolved by warm muriatic acid, which will not act on either felspar or albite.

Analyses: *a*, from Labrador, by Klaproth; *b*, from Campsie, *c*, from Milngavie, in Stirlingshire, both by Lehunt; *d*, *silicite*, by Thomson; *e*, from the lava of Etna, by Abich:—

	a.	*b.*	*c.*	*d.*	*e.*
Silica	55·75	54·67	52·34	54·8	53·48
Alumina . . .	26·50	27·89	29·97	28·4	26·46
Peroxide of iron .	1·25	0·31	0·87	4·0	1·60
Lime	11·00	10·60	12·10	12·4	9·49
Soda	4·00	5·05	3·97	...	4·10
Potash	...	0·49	0·30	...	0·22
Magnesia . . .	...	0·18	...	...	1·74
Water	0·50	...	...	0·6	0·42
	99·00	99·19	99·95	100·2	0·89 ($\dot{\mathrm{Mn}}$)
					98·40

Formula, $(\dot{\mathrm{Na}}\dddot{\mathrm{Si}} + \dddot{\mathrm{Al}}\dddot{\mathrm{Si}}) + 3(\dot{\mathrm{Ca}}\dddot{\mathrm{Si}} + \dddot{\mathrm{Al}}\dddot{\mathrm{Si}})$; with silica, 53·42; alumina, 29·71; lime, 12·35; soda, 4·52.

Labradorite sometimes forms a constituent of some lavas, also of some hornblendic rocks and porphyritic greenstone.

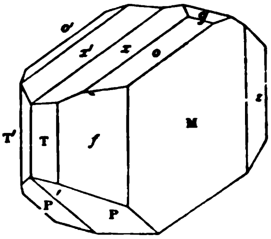
Scotland.—In greenstone at Campsie, and in small crystals at Milngavie, both in Stirlingshire. In Skye.

Ireland.—Co. Antrim; in crystalline masses in the basalt of Magee Island, and in small crystals in greenstone porphyry at Ballycastle, occasionally presenting chatoyancy. Co. Down, Mourne Mountains. Galway, lately, finely crystallized, and exhibiting a display of colours.

The *silicite* of Thomson is merely Labradorite (see analysis *d*); it occurs in Antrim of a yellowish-white colour; Sp. Gr. 2·66. Fracture conchoidal, lustre vitreous.

51. ALBITE.—Albite, *Brooke* and *Miller*, *Dana*, *Phillips*, *Beudant*; Albit, *Hausmann*, *Naumann*, *Haidinger*; Periklin, *Haidinger*.

Anorthic. Primary form a doubly oblique rhombic prism. Twins. Twin-face M, re-entering angle 173° 20′; this twinning is sometimes repeated. Two of these twins are not unfrequently combined, according to the law of the Carlsbad orthoclase twins. Cleavage very perfect, parallel to M. Fracture imperfect conchoidal, uneven. The faces M *f z* striated parallel to their intersections with each other; *x* often rough. Transparent to translucent on edges. Lustre vitreous on cleavage planes, pearly on P. Colourless, white of various shades, light-brownish, grey. Streak white. Brittle. H. 6 to 6·5; Gr. 2·6 to 2·7.



M P	93° 36'	M *z*	149° 12'
M T	117 53	M *l*	119 52
P T	115 05	P *g*	29 55
P *n*	133 55	P *x*	52 37
M *f*	148 30	*g o*	152 18
M *o*	67 49	*o x*	152 41
M *s*	120 27		

Forms: M P T *f x o z*; M P T *f x o z g*; M P T *f l x o n z* (*s g*): *n* cuts M P; *s* cuts M *x*.

Before the blowpipe melts with difficulty to a glass with bubbles, the flame being coloured distinctly yellow. Not acted upon by acids.

Analyses of albite: *a*, from Arendal, by G. Rose; *b*, from Miask, by Abich; *c*, pericline, from St. Gotthardt, by Thaulow; *d*, in trap from Dumbartonshire, in pseudomorphs after Laumonite and calcite, by Heddle:—

	a.	*b.*	*c.*	*d.*
Silica . . .	68·46	68·45	69·00	68·57
Alumina . .	19·30	18·71	19·43	20·42
Peroxide of iron	0·28	0·27	. . .	1·06
Lime . . .	0·68	0·50	0·20	0·54 Ḣ.
Magnesia . .	. . .	0·18	. . .	0·16 L̇i.
Soda . . .	9·12	11·24	11·47	9·57
Potash . . .	. . .	0·65	. . .	1·06
	97·84	100·00	100·10	100·38

$\dot{Na}\dddot{Si}+\overline{\ddot{Al}}\dddot{Si}^3$; silica, 69·09; alumina, 19·22; soda, 11·69 =100; so that albite is a true soda felspar. A small portion of the soda is sometimes replaced by lime or potash.

In attached crystals and cleavable and granular masses, generally in granite or gneiss, sometimes in greenstone or trap; occasionally replaces felspar in some granites.

LOCALITIES.—*England.* Cornwall; on quartz at Wheal Friendship. In white translucent crystals, of the form represented in the figure, in lamellar calcite and with crystals of quartz, at Tintagel, five miles N.W. of Camelford.

Yorkshire; crystallized, in greenstone, at Beverley.

Wales.—Carnarvon; in flat transparent twin crystals like the figure, *minus* the face *g*, with quartz, anatase and Brookite, at Tremadoc.

Scotland.—In cyanite and greenstone near Edinburgh; in small twin crystals at Hillswickness?, Shetland, in chlorite slate, with the form $\mathrm{MPT}flznox\,(sg)$.

Ireland.—Cork; with glassy felspar at Ross. Down; with topaz felspar and smoky quartz in the granite of Slieve Corra, one of the Mourne Mountains. Crystals very perfect, white, translucent, twinned, with the form given in the figure.

Note.—The reddish substance occurring in trap-rock in pseudomorphs after calcite, analcime and Laumonite, at Long Craig and Old Kilpatrick, Dumbartonshire, and at the Calton Hill, Edinburgh, and hitherto considered to be either analcime or Cluthalite, has been recently shown by Heddle to be albite (see analysis *d*).

52. SAUSSURITE.—Jade tenace. Felspath tenace.

Probably oblique. Supposed to be impure Labradorite. Sometimes cleavable in two directions, making an angle of about 124°. Fracture splintery, uneven. More or less translucent, opaque. Lustre dull, or slightly glimmering. Colour greyish-green, ash-grey, mountain-green. Extremely tough. H. 5·5 to 6·0; Gr. 3·25 to 3·64.

Fuses with great difficulty before the blowpipe to a greenish-grey glass. Not acted on by acids.

Analyses: *a*, from Geneva, by Saussure; *b*, from near Freiberg, by Klaproth; *c*, from Corsica, by Boulanger:—

	a.	*b.*	*c.*
Silica	44·00	51·00	43·6
Alumina	30·00	30·50	32·0
Red oxide of iron .	12·50	1·75	. . .
Lime	4·00	11·25	21·0
Magnesia . . .	. . .	. . .	2·4
Soda	6·00	4·00	. . .
Potash	0·25	(1·25 $\dot{\not{\mathrm{H}}}$)	1·6
	96·75	99·75	100·6

Formula: $\dot{\mathrm{R}}^3\dddot{\mathrm{Si}}+2\dddot{\not{\mathrm{R}}}\dddot{\mathrm{Si}}$; where $\dot{\mathrm{R}}$ may be $=\dot{\mathrm{C}}\mathrm{a}, \dot{\mathrm{M}}\mathrm{g}, \dot{\mathrm{F}}\mathrm{e}, \dot{\mathrm{N}}\mathrm{a}$; and $\dddot{\not{\mathrm{R}}}$ $\dddot{\not{\mathrm{F}}}$, $\dddot{\not{\mathrm{A}}}\mathrm{l}$, or even $\dddot{\not{\mathrm{C}}}\mathrm{r}$.

Occurs associated with eugite and hornblende; it constitutes the rocks called *gabbro* and *euphotide*.

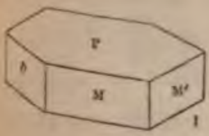
Localities.—Cornwall; it is said to occur (though it has probably been confounded with greenish diallage) at Kinance Cove, at Gwenter, and at Coverack Cove, all near the Land's End. It is also said to occur at Glen Tilt in Perthshire, and at Portsoy in Banffshire.

It may readily be distinguished from diallage and augite by its superior toughness and less decided cleavage.

53. **MUSCOVITE.**—Muscovite, *Dana*; Mica, *Brooke* and *Miller*; Mica (in part), *Phillips, Hauy*; Common Mica, Potash Mica, Biaxial Mica. Kaliglimmer, *Naumann*; Glimmer, *Haidinger, Hausmann*; Phangit, *v. Kobell.*

Oblique (according to Senarmont prismatic). Cleavage basic, very perfect. Crystals usually in the form of six-sided tables;

seldom columnar. Twin crystals occasionally occur. In thin plates flexible and elastic, very tough. Lustre, P pearly, inclining to metallic, the other faces vitreous. Colourless, white, various shades of grey, brown, green, passing into distinct yellow, grey, green and brown, the colours, however, usually not deep; sometimes black. Colours by reflected and transmitted light frequently different. Transparent, in thin leaves translucent. Biaxial; angle between the axes of polarization 45° to 75°. The optic axes lie in a plane perpendicular to P. Streak white to grey. Sectile. H. 2 to 3; Gr. 2·8 to 3·1.



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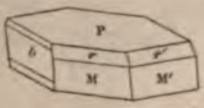

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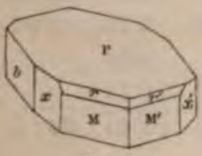


3

M M'	120° 46'
M P	98 40
M *b*	119 38
P *b*	90 00
P *r*	107 05
b x	148 30

In the matrass most varieties yield a trace of fluoric acid and also water; the latter, which probably is not an essential ingredient, is found to vary from 1 to 3 per cent. Different varieties possess very different degrees of fusibility, yielding an opaque glass or white enamel; those containing fluorine become dull on exposure to heat. Not decomposed by hydrochloric or sulphuric acid; a chemical distinction between this species and Biotite, first noticed by v. Kobell. When these species are pure, this simple test suffices for distinguishing them; sometimes, however, they occur together in the same specimen. What separates Muscovite chemically from Biotite, is rather the high per-centage of alumina and peroxide of iron than the presence of potash, which latter occurs in both species in nearly equ quantities.

Analyses: *a*, from Zsidovácz in Hungary, by Kussin; *b*, *brow* from Cornwall, by Turner; *c*, from Kimito, by H. Rose; *blackish-green*, from Vesuvius, by Chodnew; *e*, Chester Co Penn., by Smith and Brush.

In *b*, the oxidation of the iron requires further investigatio In *d*, part of the iron is supposed to be in the state of peroxid This analysis appears to show that the substance of Biotite, wit which it agrees very nearly, is dimorphous.

	a.	*b.*	*c.*	*d.*	*e.*
Silica	48·07	36·54	46·36	40·91	45·50
Alumina . . .	38·41	25·47	36·80	17·79	34·55
Peroxide of iron .	. . .	27·06	4·53	11·02	trace
Oxide manganese	. . .	1·92	. . .	. . .	(2·35 $\dot{Na}$
Lime	. . .	0·93	. . .	0·30	2·31
Magnesia . . .	. . .	. . .	. . .	19·04	1·08
Potash	10·10	5·47	9·22	9·96	8·10
Water	3·42	. . .	1·84	. . .	5·40
Hydrofluoric acid	. . .	2·70	0·71	. . .	. . .
	100·00	100·09	99·46	99·02	99·29

$\dot{K}\dddot{Si}+3\dddot{Al}\dddot{Si}$; silica, 48; alumina, 39·8; potash, 12·2=10 In most varieties doubt exists as to whether the water is, eithe in whole or part, in a state of chemical combination or othe wise, but in the Muscovite, the analysis of which is given unde the head *a*, it appears to belong essentially to the mineral, th formula for which is $2(\dot{K}\dddot{Si}+3\dddot{Al}\dddot{Si})+3\dot{H}$. From the re searches of Rammelsberg, it results that the general formula Muscovite is $m\dot{R}\dddot{Si}+n\dddot{R}\dddot{Si}$, m being usually$=1$, and $n=2, 3$ 4. For the reason stated above, the part played by the wate remains as yet undetermined.

Muscovite is an essential ingredient of primary rocks, in th fissures of which it is often found. It is likewise frequentl met with crystallized in the veins which traverse them.

The localities of Muscovite are so numerous that no general list of them can be given. Among them the following may however be cited :—

England.—Cornwall; at St. Dennis, five miles N.W. of St. Austell.

Cumberland; at Saddleback or Blencathra, and at Brandy-gill.

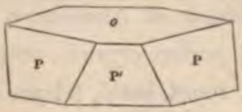
Scotland.—Aberdeenshire; fine specimens of a pinkish-brown occur in a granite quarry at Rubislaw and at Auchindoir. Banffshire; at Portsoy; the plumose variety is likewise met with here. Buteshire; in dark brown elongated six-sided plates at Coiré Bhradan. Ross-shire; very generally in granite.

Ireland.—Dublin; in fine plates in granite and felspar at Killiney. At Stepaside. The plumose variety at Three Rock Mountain. Galway; at the island of Arranmore, otherwise Inishmore. Co. Down; in very perfect crystals, presenting the form of the figures, along with topaz, beryl, felspar and albite, in the granite of the Mourne Mountains.

The name Muscovite, adapted from the trivial name *Muscovy glass,* was proposed by Dana for this species.

54. BIOTITE.—Biotite, *Brooke* and *Miller, Dana*; Mica (in part) *Hauy*; Meroxen, *Haidinger*; Biotite, *Hausmann, v. Kobell*; Magnesiaglimmer, *Naumann.* Magnesia Mica. Uniaxial Mica.

Rhombohedral. Usually in six-sided tabular crystals. Cleavage highly perfect parallel to *o*. Sectile, sometimes inclining to brittle. Pellucid, but generally in a very low degree, so much so as to render it often necessary to employ only very thin plates to recognize the uniaxial character. Lustre metallic-pearly on *o*, on the other planes vitreous. Green, brown, black, and grey, the colours usually very dark. In thin leaves flexible and elastic. Though presenting commonly in polarized light the system of rings traversed by a cross, Biotite has been shown to be, in part at least, optically biaxial by Silliman Jun^{r}. and Blake, and this conclusion is confirmed by Senarmont. Prof. Dana, from whom this statement is perhaps borrowed, remarks that the Biotite in question was probably from Vesuvius, in which case it possibly was not Biotite at all, but Muscovite, of the variety the analysis of which is given under *d* in the article Muscovite*. Brooke and Miller state that some varieties of mica exhibit two optic axes, making with each other a very small angle, and that possibly these may have been uniaxial in their normal condition, the separation of the single optic axis into two being perhaps due to the state of strain produced on the crystal in the process of detaching and cleaving it.



PP'	108° 56′
Po	110 00
ao	90 00
aa'	120 00

Combinations: Po; ao.

Biotite is generally fusible with difficulty into a grey or black glass. Is little acted on by hydrochloric acid, but completely decomposed by concentrated sulphuric acid, leaving a residue of pearly scales of silica. This decomposition of uniaxial mica in sulphuric acid serves as a ready means of distinguishing this species chemically from biaxial mica, which, with the exception of one variety that does not occur in Great Britain, is not decomposed by sulphuric acid. Biotite usually contains about 0·5 per cent. of fluorine, and from 0·4 to 4·3 per cent. of water.

Analyses: *a*, *dark green*, from Miask, by H. Rose; *b*, same, by v. Kobell; *c*, from Karosulik, Greenland, by the same:—

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* See articles *Biotite* and *Muscovite*, also in the Appendix (page 507, Dana's 'Mineralogy,' 4th edition), under *Mica*, for further particulars respecting the optical and chemical properties of these two varieties of Mica.

	a.	b.	c.
Silica	40·00	42·12	41·00
Alumina	12·67	12·83	16·16
Peroxide of iron	19·03	10·38	4·50
Magnesia	15·70	16·15	18·86
Protoxide of iron	...	9·36	5·05
Protoxide of manganese	0·63	...	...
Potash	5·61	8·58	8·76
Hydrofluoric acid	2·10	...	trace
Ferriferous $\ddot{Ti}$	1·63	...	...
Water	...	1·07	4·30
	97·37	100·49	99·35

$(\dot{Mg},\dot{Fe},\dot{K})^3\dddot{Si}+(\dddot{\bar{Al}}\dddot{\bar{Fe}})\dddot{Si}$.

In imbedded and attached crystals, usually very thin, in a direction perpendicular to *o*. In granular-foliated and scaly aggregations. Is much less widely diffused than Muscovite, biaxial or potash mica.

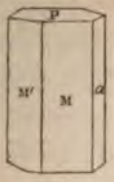
Locality.—*Scotland.* Inverness; in Mr. Greg's collection there is a large detached crystal of Biotite of a blackish colour, nearly an inch thick, from Skye; this crystal has the form given in the figure.

The name Biotite has been given to this species in compliment to Professor Biot, who was the first person that called attention to the optical differences distinguishable in micas.

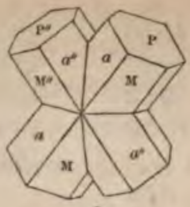
55. STAUROTIDE, *Hauy*. Staurolite. Grenatite.

Prismatic. Primitive form a right rhombic prism; crystals often twinned, and macled at right angles or obliquely. Cleavage parallel to *a*, distinct. Opaque, translucent on the edges. Lustre vitreo-resinous. Colour reddish-brown, blackish-brown. H. 7·0 to 7·5; Gr. 3·5 to 3·8.

Alone, infusible before the blowpipe. In borax, melts with difficulty into a glass coloured green by iron. Partially soluble in sulphuric acid after ignition.



1



2

M M'	129°	20'
M P	90	00
P *a*	90	00
M *a*	115	20

Analyses: *a*, from Bretagne, by Jacobson; *b*, from St. Gotthardt, by Marignac; *c*, from Ural, *d*, from Airolo, both by Jacobson :—

	a.	*b.*	*c.*	*d.*
Silica	39·19	28·47	38·33	33·45
Alumina . . .	44·87	53·34	45·97	47·23
Red oxide of iron .	15·09	17·41	14·60	16·51
Protox. manganese	0·17	0·31	. . .	. . .
Magnesia . . .	0·32	0·72	2·47	1·99
	99·64	100·25	101·37	99·18

Formula, $\dddot{\overline{\mathrm{Fe}}}{}^2\dddot{\mathrm{Si}}+2\dddot{\overline{\mathrm{Al}}}{}^2\dddot{\mathrm{Si}}$; silica, 29·3; alumina, 53·5; peroxide of iron, 17·2.

Staurotide generally occurs imbedded in mica-schist, gneiss, clay-slate, and talcose rocks.

LOCALITIES.—Occurs crystallized, of a brownish-red colour in gneiss, one mile and a half east of Woodwick, in Unst, Shetlands. At Ardonald, between Keith and Huntley, Aberdeenshire.

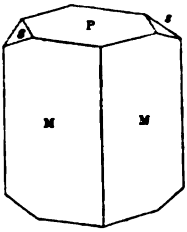
Ireland.—With schorl and Andalusite, in clay-slate, at Tornduff, Co. Carlow. At the junction of the mica-slate and granite near Killiney, a few miles south of Dublin. In small rough crystals, much interlaced, and of a brownish-black colour, in Glen Malure, Co. Wicklow, in a hard talcose rock.

Ferruginous impressions, presenting the form of figure 2, probably of this mineral, have been found in a compact vitrified sandstone in the south of Ireland; the precise locality, however, is not stated.

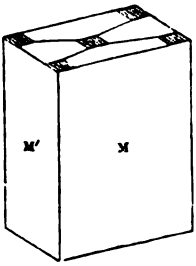
Derived from σταυρὸς, *a cross.*

56. ANDALUSITE.—Andalusite, *Brooke* and *Miller*, *Phillips*, *Dana*; Red Schorl, Feldspath, Apyre, Macle, *Hauy*; Andalusit, *Haidinger*, *Hausmann*; *Naumann*, *v. Kobell*. Chiastolite.

Prismatic. Primary form a slightly rhombic prism. Cleavage tolerably distinct parallel to M. Fracture uneven, splintery. Translucent on the edges. Vitreous lustre seldom decided, sometimes dull. Colour pearl-grey, greenish-grey, reddish-brown, violet-blue, peach-blossom-red, flesh-red, reddish-grey. Tough. Streak white. H. 7·0 to 7·5; Gr. 3·1 to 3·2. For H. and Gr. of chiastolite, see next page.



1



2

M M' 90° 44'
M P 90 00
P *s* 144 55

Combinations: M P; M P *s*.

Infusible before the blowpipe. Becomes blue with solution of cobalt. Scarcely attacked by acids.

Analyses of *Andalusite* from Lisens in the Tyrol: *a*, by Bunsen; *b*, by Erdmann; *c*, *chiastolite*, from Lancaster, Massachusetts, by Bunsen; *d*, by Jackson; *e*, from Bona, Algiers, by Renou.

	a.	*b.*	*c.*	*d.*	*e.*
Silica	40·17	39·99	39·09	33·0	36·6
Alumina	58·62	58·60	58·56	61·0	61·9
Oxide manganese	0·51	0·83	0·53	$\dddot{\bar{\text{F}}}\text{c}$ 4·0	*traces of*
Lime	0·28	$\dddot{\bar{\text{F}}}\text{e}$ 0·72	0·21	...	$\dddot{\bar{\text{F}}}\text{e}$&$\dot{\text{M}}\text{g}$
Volatile matter .	...	...	0·99	$\dot{\bar{\text{H}}}$ 1·5	...
	99·58	100·14	99·38	99·5	98·5

$\ddot{\text{Al}}^4\dddot{\text{Si}}^3$; silica, 40·27; alumina, 59·73 = 100.

In attached and imbedded crystals, principally in gneiss or mica-slate.

Localities of Andalusite.—*England.* Devon; is said to occur near Dartmoor.

Scotland. — Aberdeenshire; at Auchindoir. In mica-slate, well crystallized, reddish, in parish of Kildrum, and at Glen Mid Cliva. On borders of Kincardine and Aberdeenshire. Banffshire; near Portsoy. Shetlands; in mica-slate, in Unst.

Ireland.—Donegal; on Scalp Mountain, four miles W.N.W. of Muff; and near Loch Salt in schist. Wicklow; on Douce Mountain. At Lugganure, at Glendalough and Glen Malure with quartz, mica, and margarodite.

The Wicklow crystals are sometimes altered into a substance which, in composition, agrees probably with cyanite, that is to say, having been originally $\dddot{\bar{\mathrm{A}}\mathrm{l}}^{4}\dddot{\mathrm{Si}}^{3}$, they are now converted into $\dddot{\bar{\mathrm{A}}\mathrm{l}}^{3}\dddot{\mathrm{Si}}^{2}$. There are several instances of this pseudomorphism occurring at foreign localities; for instance, at Munzig, at Fahlun, and at Herzogau.

Chiastolite, according to Brooke and Miller, "appears to be a variety of Andalusite having prisms of a darker substance in the centre, and sometimes in each angle, connected by thin plates of the same. The dark portions are either the slate, in which the crystals are imbedded, or discolorations produced by carbonaceous matter, which disappear on igniting the crystal." Beudant looks upon the crystals of chiastolite as simple crystals with extraneous matter arranged with regularity in the process of crystallization. H. 5 to 5·5; Gr. 2·9 to 2·15.

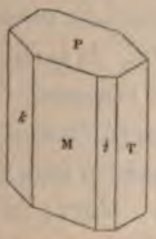
Localities of Chiastolite.—*England.* Cumberland; in transition slate at the top of Skiddaw, very plentiful, of a greyish-white. At Saddleback. At Dacre Castle near Ullswater; and in roofing-slate at Carrock Fells.

Devon; in small crystals, like figure 2, at Ivy Bridge, three miles N.W. of Modbury.

Ireland.—Dublin; in confused crystals in mica-slate near Killiney Bay. Wicklow; at Agnavaugh. In grey crystals, crossing each other, in mica-slate at Baltinglass Hill, on the borders of Carlow.

57. **CYANITE.**—Kyanite, *Brooke* and *Miller*, *Dana*, *Phillips*; Disthène, *Hauy*; Disthen, *v. Kobell*, *Naumann*; Cyanit, *G. Rose*; Kyanit, *Haidinger*. Rhœtizite.

Anorthic. According to Naumann oblique. Primary form a doubly oblique rhombic prism. Cleavage M very perfect, T less perfect, P least perfect, parallel with the smoother lateral plane very perfect, basic imperfect. Crystals seldom terminated. Twin crystals common: according to G. Rose, there are two kinds of twinning, in which the main axes are parallel. Fracture uneven. Transparent to translucent. Lustre vitreous, except on M, or plane of easiest cleavage, which is pearly. Colourless, white, blue, yellowish-brown, grey, greenish. Dichroitic in polarized light. Streak white. Brittle. H. 5 to 7; Gr. 3·5 to 3·7.



P M	90° 50′
P T	93 15
M T	106 16
M *k*	131 23
M *i*	145 31

Infusible before the blowpipe. Soluble in salt of phosphorus, leaving a skeleton of silica. Moistened with solution of cobalt and exposed to a strong heat, it assumes a deep blue colour. Not acted upon by acids.

Analyses: *a*, *b*, from St. Gotthardt; *c*, foliated, from Röraas, Arfvedson; *d*, from the Tyrol, by Erdmann:—

	a.	*b.*	*c.*	*d.*
Silica	34·33	36·9	36·4	37·36
Alumina . . .	64·89	64·7	63·8	62·09
Peroxide of iron .	...	...	...	0·71
	99·22	101·6	100·2	100·16

$\overline{\text{Al}}^3\overline{\text{Si}}^2$; silica, 37·48; alumina, 62·52 = 100, according to the view which G. Rose takes of its constitution; while Rammelsberg, founding his opinion upon the researches of Arfvedson, holds the true formula of cyanite to be $\ddot{\text{Al}}^2\overline{\text{Si}}$, which would require silica, 31·01; alumina, 68·99 = 100. The excess of silica obtained in the analyses he attributes to a constant admixture of that substance.

In imbedded crystals in mica-slate, talc-slate, and gneiss; in columnar and fibrous masses. Pseudomorphous after Andalusite. It is the broad-columnar blue variety which is termed cyanite; the grey, bladed, interlaced variety has been called rhœtizite.

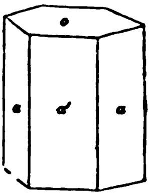
LOCALITIES.—*Scotland.* Aberdeenshire; at Banchory. Banffshire; blue, crystallized, at Botriphinie. In Boharm parish. Perthshire; in quartz near summit of Ben-y-Gloe near Glen Tilt. Shetlands; finely crystallized (like the figure), at Hillswickness Point. The variety called *rhœtizite* occurs here of a reddish-grey along with the blue variety. It is also met with a little to the north of Vanleep, imbedded in quartz. The crystals at Hillswickness are sometimes terminated distinctly, blue and transparent: Dr. Heddle has a fine specimen from this locality.

Ireland.—Donegal; at Altnopastie. Mayo; in mica-slate, at Erris.

The name cyanite is derived from κύανος, *dark blue.* Rhœtizite, from the Rhœtian Alps, Tyrol, where the mineral is found.

ERYL.—Emerald, *Brooke* and *Miller*; Beryl, Emerald, *Phillips*; Emeraude, *Hauy*; Beryll, *Naumann*; Smaragd, *Haidinger*, *Hausmann*, *v. Kobell*.

hombohedral. Cleavage parallel to *o*; imperfect parallel L. Fracture conchoidal, uneven. Transparent, translucent. stre vitreous. White, occasionally colourless, generally, hower, green, blue, yellow. The prism is frequently striated vercally. H. 7·5 to 8; Gr. 2·6 to 2·8.



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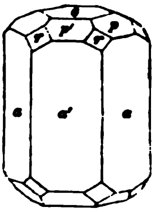

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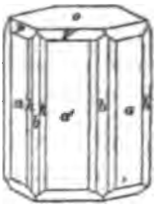

3

a a'	120° 00′	*a o*	90° 00′	*o p*	150° 03′	*p p'*	151° 05′
a b	150 00	*b h*	169 06	*o r*	135 04	*r r*	104 34
b o	90 00	*a r*	127 43				

The forms *a o*; *a o r*; *a o b*; *a o p r*; *a o b p h*; *a o b p r*, occur at the Mourne Mountains locality.

Before the blowpipe is fusible with difficulty, and that only on the edges, to a cloudy blebby glass. Dissolved in salt of phosphorus, leaving a skeleton of silica. Not attacked by acids.

Analyses: *a*, *emerald*, by Klaproth, *b*, *emerald*, by Vauquelin, both from Peru; *c*, *beryl*, from Siberia, by Du Menil; *d*, *beryl*, from Broddbo, by Gmelin:—

	a.	*b.*	*c.*	*d.*
Silica	68·50	64·40	67·00	69·70
Alumina . . .	15·75	14·00	16·50	16·83
Peroxide of iron .	1·00	...	1·00	0·24
Glucina	12·50	13·00	14·50	13·39
Lime	0·25	2·56	0·50	...
Oxide of chrome .	0·30	3·50	...	...
	98·30	97·46	99·50	100·16

$\dot{Be}^3\overline{Si}^2+\overline{Al}\,\overline{Si}^2$; silica, 67·41; alumina, 18·75; glucina, 13·8 =100. G. Rose, in his 'Mineralsystem,' gives $(\ddot{Be}+\ddot{Al})\overline{Si}^2$, taking glucina to be $\ddot{Be}$, while Rammelsberg supposes it to be $\dot{Be}$.

In attached and imbedded crystals, in broken crystals and pebbles, in alluvium. The emerald-green variety does not occur in the United Kingdom.

Localities.—*England.* Cornwall; in small bluish crystals, with topaz and cassiterite, at St. Michael's Mount. In dull white crystals, well defined, in fine-grained granite, in Mabe parish, three miles west of Falmouth. In Constantine parish, five miles S.W. of Falmouth. Amorphous at Wheal Castle near St. Just.

Scotland.—Aberdeenshire; at Kinloch Rammoch. At Mount Battock (borders of Kincardine and Forfar, where they meet Aberdeen), in diverging prisms of a pale green, in granite. With topaz, near Braemar, in the alluvium of the Don and Dee. The Aberdeenshire beryls are usually straw-yellow or apple-green, and inferior as specimens to those from the Mourne Mountains, though a few very large and nearly transparent crystals have been found. Banffshire; Cairngorum or Cairngorm, in the granite and gneiss. Said to occur also in primitive limestone at Portsoy. The *Davidsonite* of Richardson and Thomson is beryl; occurring in greenish-yellow crystals at the granite quarry of Rubislaw near Aberdeen*.

Ireland.—Down; in the Mourne Mountains very fine specimens have been met with, mostly of a fine blue, sometimes quite transparent, and of considerable size. Some of the forms have been mentioned above. They occur with topaz, crystals of felspar, and black quartz on Slieve Corra. In large crystals, with rough surfaces, on the west side of the Rocky Mountain. In tolerably good crystals on the N.W. side of the small lake on Binion Hill, with black quartz and felspar. In fine radiating crystals on Slieve Hevila, three miles S.S.W. of Lord Roden's castle, with manganese and iron, in cavities in felspar and quartz. The finest crystals obtained by Mr. Patrick Doran were from the Chimney Rock Mountain on Lord Newry's property.

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* Dr. Heddle found 12·52 per cent. of glucina in Davidsonite, thus proving it, were there indeed any doubt, to be merely beryl. He states that it occurs also at Tory, on the south side of the Dee, opposite the town of Aberdeen.

In Mr. Turner's collection there is a crystal of beryl from the Mourne Mountains, cut and polished parallel to the face *o*, exhibiting decided opalescence, and showing a six-rayed star like some varieties of corundum.

Co. of Dublin; in the granite and quartzose rocks in the neighbourhood of Killiney and Dalkey, in pale greenish opaque crystals, sometimes several inches in length; schorlous, at the Three Rock Mountain; also at Stillorgan. In Wicklow, it is said also to occur with schorl and garnets near Round Wood in Glen Malure, and also in Glen Macarnass.

The word beryl is derived from "*berillus*," the name used for this species as long ago as the time of Pliny.

59. SPODUMENE.—Spodumene, *Brooke* and *Miller*, *Dana*, *Phillips*; Triphane, *Hauy*; Triphan, *Hausmann*, *v. Kobell*; Spodumen, *Haidinger*.

Oblique. Primary form an oblique rhombic prism. Isomorphous with augite. Cleavage highly perfect parallel to *a*, less so to *b**. Structure often lamellar. Fracture uneven, splintery. Translucent, often only on the edges, opaque. Lustre vitreous, upon the most perfect cleavage plane pearly. Greenish-white to apple-green, and light greenish-grey. Brittle. Streak white. H. 6·5 to 7; Gr. 3·07 to 3·2.

Intumesces before the blowpipe, colouring the flame slightly and transiently red, and melts easily into a transparent glass.

* See figure of *Augite*, page 139.

On the addition of fluor and bisulphate of potash the flame is coloured vividly purple. With solution of cobalt it becomes blue. Dissolves in salt of phosphorus, leaving a skeleton of silica. Not acted upon by acids.

Analyses: *a*, from Utö, by Hagen; *b*, from Utö, *c*, from the Tyrol, both by Rammelsberg:—

	a.	*b.*	*c.*
Silica	65·02	65·02	65·53
Alumina	26·84	29·14	29·04
Protoxide of iron . .	0·86	trace	1·42
Lime	...	0·50	0·97
Magnesia	...	0·14	0·07
Lithia	3·84	5·47	4·49
Soda	2·68	0·46	0·07
Potash	...	0·14	0·07
	99·24	100·87	101·66

$4\dddot{\bar{Al}}\dddot{Si}^2+\dot{Li}^3\dddot{Si}^2$; silica, 65·2; alumina, 28·8; lithia, 6=100, a portion of the lithia being usually replaced by protoxide of iron and soda; or $\dot{Na}\dddot{Si}+3\dot{Li}\dddot{Si}+6\dddot{\bar{Al}}\dddot{Si}^2$; with silica, 65·87; alumina, 27·49; lithia, 3·86; soda, 2·78.

Locality. — In considerable masses, and in long bent prisms of a greenish-grey colour in white granite at Killiney, Co. Dublin, associated with Killinite, schorl, and garnet, in small crystals. It is much harder than the Killinite, which it sometimes resembles. No terminated crystals have as yet been observed at this the only locality in the United Kingdom, but in Mr. Greg's collection there is a specimen showing the faces *a b m* of Brooke and Miller. Dr. Heddle has a very large rough crystal from this locality. The Killiney spodumene is occasionally employed as a source for procuring lithia.

The name spodumene is derived from *σπόδιος*, *ash-coloured.*

60. KILLINITE, *Thomson*, *Phillips*; Spodumene, *Dana.* ?

Oblique. ? One pretty perfect cleavage, *a*; two less perfect, making angles of 134° 30′ and 126° 45′ with *a*, and in the same zone. Structure slightly fibro-lamellar. Colour light-green, staining the granite brownish-yellow. Translucent on edges. Brittle. Yields easily to the knife. H. 3·5 to 6·0; Gr. 2·56.

Turns black in the open tube when heated. With blowpipe on charcoal, fuses to a white enamel with some intumescence. Scarcely acted on by acids.

Analyses: *a*, by J. W. Mallet, *b*, by Lehunt, *c*, by Blyth, all from Killiney; *d* (*pinite*), from Penig; *e* (*pinite*), from Auvergne; *f*, *Fahlunite*:—

	a.	*b.*	*c.*	*d.*	*e.*	*f.*
Silica	52·89	49·08	47·93	47·00	55·96	44·60
Alumina . . .	33·24	30·60	31·04	28·36	25·48	30·10
Protox. iron .	3·27	2·27	2·33	7·08	5·51 }	3·86
Lime	1·45	0·68	0·72	0·79	$\ddot{\mathrm{F}}\mathrm{e}$ }	1·35
Magnesia . .	...	1·08	0·46	2·48	3·00	6·75
Potash	4·94	6·72	6·06	10·74	7·89	1·98
Soda	...	...	...	1·07	0·39	...
Protox. mang. .	...	...	1·25	...	0·76	2·24
Lithia	0·46	...	...	...	...	...
Water	3·67	10·00	10·00	3·83	1·41	9·35
	99·92	100·43	99·79	101·35	100·40	100·23

Formula, $(\dot{\mathrm{R}}\dddot{\mathrm{Si}}+2\dddot{\mathrm{Al}}3\dddot{\mathrm{Si}})+4\dot{\mathrm{H}}$; with silica, 49·88; alumina, 27·68; potash, 12·72; water, 9·72; the protoxides being all taken as potash.

This mineral was discovered by Dr. Taylor in 1817, at Killiney Hill near Dublin. Good specimens were lately obtained in making the railway cutting on the S.E side of Killiney Hill; also near Dalkey and Scalp, in the immediate neighbourhood, in long irregular prisms, imbedded in white granite, with spodumene, garnet and schorl.

Killinite has lately been carefully analysed by the Rev. J. A. Galbraith; the specimen *g* was found one mile and a half from the Victoria Castle near Killiney; *h*, from near Dalkey; *i*, by

Barker; no lithia was obtained; and he suggests the formula $(\dot{R}\dddot{Si}+2\dddot{Al}3\dddot{Si})+3\dot{\bar{H}}$; silica, 51·12; alumina, 28·37; potash, 13·04; water, 7·47:—

	g (Killiney).	*h* (Dalkey).	*i* (Sp. Gr. 2·683).
Silica	50·45	50·11	52·49
Alumina . . .	30·13	29·37	24·50
Protoxide of iron	3·53	2·23	2·49
Lime	...	0·34	$\dot{Mn}$ 0·75
Magnesia . .	1·09	1·03	0·50
Potash . . .	4·81	6·71	5·00
Soda	0·95	0·60	...
Water . . .	7·58	8·03	5·00
	98·54	98·42	90·73

Note.—Though Killinite has recently been placed by Haidinger and Blum among the altered forms of iolite, along with pinite, gigantolite, Giesekite, Fahlunite, &c., to which it appears, indeed, nearly related in composition*, yet with due deference to the opinion of these mineralogists, it has in this work been considered advisable to retain Killinite as a distinct species. In structure, form, and cleavage it appears quite distinct, neither a pseudomorph nor an altered form. The form of iolite and of the large class of altered minerals derived from it is very distinct. This is by no means the case with Killinite; the *basal* termination always present in the iolite and pinite class, is in Killinite entirely absent, either as a plane of cleavage or a natural face.

61. OBSIDIAN.—Pitchstone. Sphærulite. Pearlstone. Petrosilex. Pumice. Felspar (in part).

These substances are all supposed to be mechanical mixtures, arising chiefly from the fusion, in differing proportions, of felspar and quartz.

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* See analyses *d*, *e* and *f*, page 129. The absence of lithia would almost preclude the idea that Killinite is an altered spodumene, as given in Dana's 'Mineralogy.'

Amorphous. Fracture imperfect conchoidal, splintery; more or less vesicular, or in concentric concretions. Lustre resinous (in pitchstone), vitreous (in obsidian), pearly (in pearlstone). Colour dark green, black, brown, grey, red, yellow. Translucent on edges, often resembling glass in its nature. H. 5·5 to 6·0; Gr. 2·2 to 2·8.

Before the blowpipe melts with intumescence into a porous or vesicular glass.

Analyses: *a*, *pitchstone* from near Newry, Co. Down, by Knox; *b*, do. from Arran, by Thomson; *c*, *pearlstone* from Hungary, *d*, *obsidian* from Telkibanya, both by Erdmann; *e*, *petrosilex* from Brittany, by Berthier:—

	a.	*b.*	*c.*	*d.*	*e.*
Silica	72·80	63·50	72·87	74·80	75·4
Alumina	11·50	12·74	12·05	12·40	15·5
Peroxide of iron .	...	...	1·75	2·03	...
Lime	1·12	4·46	1·30	1·96	...
Magnesia	...	...	1·10	0·90	1·4
Soda	2·88	6·22	...	...	...
Potash	...	...	6·13	6·40	3·8
Protoxide of iron .	3·03	3·80	...	1·31(Mn)	1·2
Water and loss .	8·50	8·00	3·00	...	...
	99·83	98·72	98·20	99·80	97·3

Obsidian occurs with porphyry of a jet black colour in Arran, at Glen Cloy, and at Dromo Dune in granite; of a leek-green colour near Newry, Co. Down, in granite; vesicular and like pumice at the Giant's Causeway, Co. Antrim; and occasionally at Craighulliar near Portrush, of a velvet black colour; in Cornwall, at Clowance Park near Helstone, sparingly, in granite.

Pitchstone occurs in Arran at Dun Doo, and Coiré-ghil-moor in veins traversing sandstone; in the islands of Rum, Canna, Mull and Lamlach; Argyleshire, occasionally in trap; Hebrides, constituting a remarkable vein at the Skuir of Eigg.

Ireland.—Co. Antrim at Sandy Braes; Co. Down at Glassdrummond, and near Newry.

England.—In Cornwall, as at South Bassett and some of the Camborne mines, with granite, and at Skewes near Crowance.

Pearlstone occurs in Arran of a yellowish-brown colour with pitchstone, and at Sandy Braes in Antrim.

Sphærulite is merely obsidian or pearlstone in spherules or globular concretions; it occurs of a dark brown colour, with a fibro-radiating structure in a soft friable clay in one of the Shetlands. In Arran.

Petrosilex is a compact impure felspar, like the base of porphyry; it differs from jasper, which it often resembles, by being fusible: occurs in Scotland.

62. ISOPYRE, *Turner, Phillips.*

Amorphous. Fracture conchoidal. Opaque, translucent on edges. Lustre vitreous to resinous. Black. Streak greenish-grey. Brittle. H. 6·0 to 6·5; Gr. 3·0.

Before the blowpipe fuses readily to a magnetic bead. On platinum colours the flame greenish. Scarcely acted on by acids.

Analysis, by Turner, of a specimen from Cornwall:—

Silica	47·09
Alumina	13·91
Red oxide of iron .	20·07
Lime	15·43
Oxide of copper . .	1·94
	98·44

Formula, $\dot{Ca}\dddot{Si}+(\dddot{Al}\dddot{Fe})\dddot{Si}$; with silica, 49·66; alumina, 13·78; peroxide of iron, 21·51; lime, 15·05.

This species was first distinguished by Haidinger; it has a fainter lustre than obsidian.

It forms compact masses, sometimes two inches thick, in the granite near St. Just and Penzance, and is associated with tourmaline and tinstone.

It resembles the trachylite of Breithaupt.

A similar mineral occurs at the Calton Hill, Edinburgh, in breccia, with limonite.

63. CORDIERITE.—Iolite, *Phillips*. Dichroite. Peliom.

Prismatic. Primitive form a right rhombic prism. Fracture conchoidal, uneven. Translucent, transparent. Colour blue, inclining to purple, grey, or brown. Exhibits pleochroism; often deep blue along the vertical axis, red brownish-yellow perpendicular to it. Lustre vitreous to resinous. H. 7·0 to 7·5; Gr. 2·6 to 2·7.

Melts with difficulty on the edges with the blowpipe. With soda intumesces and becomes infusible. Imperfectly decomposed by acids.

Analyses: *a*, from Bodenmais, by Stromeyer; *b*, from Haddam, in Connecticut, by Jackson:—

	a.	*b*.
Silica	48·35	48·35
Alumina	31·71	32·50
Protoxide of iron . . .	8·32	6·00
Magnesia	10·16	10·00
Protoxide of manganese	0·33	0·10
Water	0·59	...
Loss by ignition . . .	...	3·10
	99·46	100·05

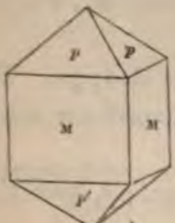
Formula, $\dot{R}^3\dddot{Si}^2+3\ddot{R}\dddot{Si}$, where $\dot{R}$ is $\dot{Mg}$ and $\dot{Fe}$; and $\ddot{R}$ is $\ddot{Al}$; with silica, 49·6; alumina, 33·8; magnesia, 8·7; protoxide of iron, 7·9.

In imbedded crystals and granular masses, with granite, gneiss, magnetic pyrites, &c.

Mentioned in Portlock's 'Geological Survey of the N.E. of Ireland' as occurring in the Island of Rathlin. Said also to occur at Dalkey, near the river Dodder, Co. Dublin, and in Argyleshire.

64. ZIRCON.—Zircon, *Brooke* and *Miller*, *Dana*, *Phillips*, *Hauy*, *Hausmann*; Zirkon, *Haidinger*, *v. Kobell*, *Naumann*.

Pyramidal. Primary form an obtuse octahedron, with a square base. Cleavage rather indistinct parallel to *p* and M. Fracture conchoidal to uneven. Lustre vitreous, often adamantine. Transparent to translucent on the edges. Red, brown, grey, white, colourless. Streak in the coloured varieties lighter than the colour. H. 7·5; Gr. 4·4 to 4·7; according to Svanberg, the Gr. ranges from 4·072 to 4·681.



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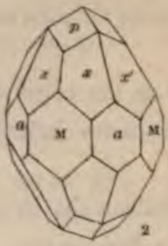

2

M M	90° 00′
M *a*	135 00
p p	123 19
p p′	84 20
x x′	147 03
x a	148 17

British forms: M *p*; M *x p*; M *a x p*.

Before the blowpipe remains infusible, but loses its colour; soluble in borax with difficulty, insoluble in salt of phosphorus. Not acted upon by acids, with the exception of sulphuric acid, by which it is partially decomposed after continuous digestion.

Analyses: *a*, from Ceylon, by Vauquelin; *b*, from Expailly, by Berzelius; *c*, from Litchfield, by Gibbs; *d*, from Grenville, by Hunt:—

	a.	*b.*	*c.*	*d.*
Silica	32·6	33·48	35·39	33·7
Zirconia	64·5	67·16	63·56	67·3
Peroxide of iron . .	1·5	...	0·79	...
	98·6	100·64	99·74	101·0

$\ddot{Zr}\dddot{Si}$; silica, 33·61; zirconia, 66·39=100.

Usually occurs in imbedded crystals in granite, gneiss and syenite. In alluvium and sand of rivers.

Localities.—*Scotland.* Argyleshire; at Strontian, like figure 1. In Sutherlandshire. Hebrides; Isle of Harris, in crystals, like figure 2, and also M x p. The crystals, said to occur at Criffel in Kirkcudbrightshire, are sphene.

Ireland.—In the auriferous streams of the Croghan Kinshela Mountain.

65. OLIVINE.—Chrysolite, *Phillips*; Peridot, *Hauy*.

Prismatic. Cleavage perfect parallel to *a*. Fracture conchoidal. Lustre vitreous. Transparent, translucent. Colour yellow, green, brown. H. 6·0 to 7·0; Gr. 3·3 to 3·5.

Grows dark before the blowpipe, but infusible alone. With soda melts into a brown slag. Is readily decomposed by sulphuric acid, forming a jelly.

Analyses: *a*, *oriental* chrysolite, by Stromeyer; *b*, from Monte Somma, by Walmstedt; *c*, Olivine, from the basalt of Langeac, by Berthier; *d*, from lava, Iceland, by Genth:—

	a.	*b.*	*c.*	*d.*
Silica	39·73	40·12	40·8	43·44
Magnesia . . .	50·13	44·54	41·6	49·31
Protoxide of iron .	9·19	15·32	16·4	6·93
Oxide of nickel . .	0·32	. . .	. . .	0·32
Oxide of manganese	0·09	0·29	. . .	. . .
Alumina	0·22	0·14	. . .	traces
	99·68	100·41	98·8	100·00

Formula, $10\dot{M}g^3\dddot{S}i+\dot{F}e^3\dddot{S}i$; with silica, 41·19; magnesia, 50·27; protoxide of iron, 8·54; $\dot{M}n$ and $\dot{C}a$ sometimes replace the $\dot{M}g$. Pure silicate of magnesia has silica, 42·75; magnesia, 57·25.

Localities.—*England.* In basalt, at Teesdale in Durham.

Scotland.—In trap-rock, at Arthur's Seat near Edinburgh, and similarly in the islands of Rum and Skye.

Ireland.—Antrim; in basalt and trap near the Giant's Causeway, of an olive-green colour and brownish, disseminated and in small crystalline masses; with augite at Fairhead; in small grains in trap at Ballintoy. At Agnew's Hill, partially decomposed and possessing a semi-metallic lustre. At Whitehouse, near Belfast; of a fine cherry-red colour and translucent, and in large crystalline concretions, in the trap of Magee Island. Londonderry; in basalt at Drumachose. Co. Down, near Glasdrummond.

66. GADOLINITE.—Gadolinite, *Phillips, Hauy, Mohs.*

Prismatic ?. Oblique ?. Primary form probably an oblique rhombic prism. Rarely well crystallized. Cleavage not perceptible. Fracture conchoidal to uneven. Opaque; translucent on edges. Lustre vitreous, inclining to resinous. Black, sometimes brownish-red. The black varieties often greenish by transmitted light. Streak greenish-grey. H. 6·5; Gr. 4·3.

Analyses: *a*, from Hitteröe, by Scheerer; *b* and *c*, from Ytterby, both by Berlin:—

	a.	*b.*	*c.*
Silica	25·59	24·86	24·85
Yttria	44·96	48·32	51·46
Protoxide of cerium . .	...	7·41	5·24
Oxide of lanthanium .	6·33		
Protoxide of iron . .	12·13	14·80	13·01
Glucina	10·18	3·50	4·80
Lime	0·23	0·67	0·50
Magnesia	traces	0·67	1·11
Protoxide of manganese			
	99·42	100·23	100·97

Formula, $\dot{\mathrm{R}}^3\dddot{\mathrm{Si}}=(\dot{\mathrm{F}}\mathrm{e}^6\dddot{\mathrm{Si}}+2\dot{\mathrm{Y}}^3\dddot{\mathrm{Si}})+(\dot{\mathrm{C}}\mathrm{e}^6\dddot{\mathrm{Si}}+2\dot{\mathrm{Y}}^3\dddot{\mathrm{Si}})$?; with silica, 23·56; yttria, 49·15; protoxide of cerium, 16·54; protoxide of iron, 10·75.

Before the blowpipe decrepitates, and swells into a cauliflower-like mass, but does not fuse. Some varieties glow when heated. Forms with borax a dark glass deeply tinged with iron, and in the reducing-flame becomes bottle-green. Gelatinizes in muriatic acid, leaving a jelly of silica.

Gadolinite was first discovered in the United Kingdom in the county of Galway by W. Mallet, Esq., of Dublin. Only one small specimen was found, about the size of a hazel-nut.

Dr. Heddle supposes that a black vitreous mineral which occurs along with sphene and Allanite in particles about the size of a pea in syenite, a mile west of New-Abbey, Kirkcudbrightshire, may be Gadolinite.

67. ALLANITE, *Mohs, Phillips*; Orthite, *Haidinger*.

Oblique, and isomorphous with epidote. Fracture conchoidal, uneven. Opaque. In thin splinters feebly translucent. Lustre imperfect, metallic, inclining to vitreous or resinous. Black, passing into reddish or greenish-brown. Brown by transmitted light. Brittle. H. 6·0; Gr. 3·1 to 4·2.

Melts before the blowpipe with intumescence into a brown or black magnetic glass. Most varieties are decomposed by hydrochloric acid, forming a jelly.

Analyses: *a*, from Snarum; *b*, from Greenland; *c*, from Hitteröe; *d*, from Miask; *e*, from Finbo:—

	a.	*b.*	*c.*	*d.*	*e.*
Silica . . .	35·75	33·02	33·81	34·08	36·25
Alumina . .	15·49	15·23	13·04	16·86	14·00
Red oxide iron Protox. iron .	15·19	15·10	8·16 8·30	7·35 7·90	11·42
Protox. cerium Ox. lanthanium	19·96	21·60	20·50 ($\dot{Mn}$)	21·38 ($\dot{K}$)	17·39
Yttria . . .	...	...	1·45	...	3·80
Lime . . .	11·25	11·08	9·42	9·28	4·87
Magnesia . .	0·77	...	0·38	0·95	1·36 ($\dot{Mn}$)
Water . . .	...	3·00	3·38	1·32	8·70
	98·41	99·03	98·44	99·12	97·79

Formula, $\dot{R}^3\ddot{Si}+\ddot{R}\ddot{Si}$; where $\dot{R}$ is $\dot{Ca}$, $\dot{Ce}$, $\dot{Fe}$, and $\ddot{R}$ is $\ddot{Al}$ and sometimes $\ddot{Fe}$.

Allanite has recently been discovered by Dr. Heddle in very small crystals (showing the faces M T of epidote) engaged in syenite near Criffel, along with small crystals of sphene, in a glen a mile west of New-Abbey near Criffel, in East Kirkcudbrightshire.

68. WOLLASTONITE, *Hausmann, Haidinger*; Tabular spar, *Phillips*; Prismatischer Augit Spath, *Mohs*.

Oblique. Principal cleavages parallel to P and *u* in pectolite. Fracture uneven and splintery. Translucent. Lustre vitreous, inclining to pearly on the cleavages. White, passing into grey, yellow or brown. Streak white. Rather brittle. H. 5·0; Gr. 2·85.

Melts with difficulty before the blowpipe into a semitransparent glass. Is soluble in borax and salt of phosphorus, leaving a skeleton of silica. Is completely decomposed by hydrochloric acid, leaving a jelly of silica.

Analyses: *a*, by Bonsdorff, from Skräbböle in Finland; *b* and *c*, by Heddle, from Dunmore Head, Ireland:—

	a.	*b.*	*c.*
Silica	52·58	50·434	51·36
Lime	44·45	43·920	42·50
Magnesia . . .	0·68	·396	·48
Red oxide of iron	0·13	·840	·98
Water	0·99	1·360	1·48
Carbonic acid . .	...	2·371	not det.
	98·83	99·321	96·80

Formula, $\dot{Ca}^3\dddot{Si}^2$*; with silica, 51·96; lime, 48·04.

Localities.—Occurs massive, and with a confusedly fibrous texture, and of a pure white colour, at Dunmore Head, on the shores of the Mourne Mountains, Co. Down, with calc-spar and serpentine.

Scotland.—With idocrase, in Glengairn in Aberdeenshire.

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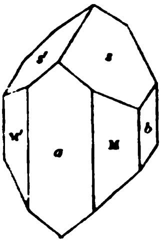
* Or, more generally, $\dot{R}^3\dddot{Si}^2$, which also represents the formula for augite.

69. AUGITE.—Augite, *Brooke* and *Miller*; Pyroxene, *Dana*; Augite, Pyroxene, *Phillips*; Pyroxène, *Haüy*; Augit, *Haidinger*, *v. Kobell*; Augit, Amianth, Diopsid, Malacolith, *Hausmann*. Sahlite. Pyroxen, *Naumann*.

Oblique. Primary form an oblique rhombic prism. Cleavage parallel to M tolerably perfect; *a*, *b*, *s*, traces. The faces *a* and *b* striated parallel to their intersections with each other. Twins not unfrequent; the twinning according to several laws, but usually the main axis is the twin axis. Fracture conchoidal, uneven. Lustre vitreous. Colourless, sometimes white, usually, however, coloured, especially grey, green and black. Streak white to grey. Brittle. H. 5 to 6; Gr. 3·2 to 3·5.



M M′	87° 06′		
M *a*	133 55	(Naumann, 133° 33′)	
M *b*	136 27		
a b	90 00		
s b	119 44		
s s	120 31		

Forms: M *b s*; M *a b s*.

Before the blowpipe some augites fuse quietly, others give off vesicles to some extent, and produce a white, grey, green or black glass. With borax and salt of phosphorus most varieties afford the reaction of iron. In the latter salt, however, they are, generally speaking, soluble only with difficulty; the aluminiferous varieties are indeed hardly acted upon by it. The white and light-coloured varieties become red with solution of cobalt. But slightly affected by acids.

Analyses: *a*, the green and transparent variety called diopside, from the Fassathal, by Wackenroder; *b*, the whitish or grey variety called *Sahlite*, from *Sahla*, by H. Rose; *c*, brown, from Pargas in Finland, by Nordenskiöld; *d*, black, from Vesuvius, by Kudernatsch; *e*, asbestiform, from an unknown locality, by Gruner:—

	a.	*b.*	*c.*	*d.*	*e.*
Silica . . .	54·15	54·86	51·80	50·90	43·9
Alumina . .	0·20	0·21	6·56	5·37	1·9
Lime . . .	24·74	23·57	19·07	22·96	0·5
Magnesia . .	18·22	16·49	12·01	14·43	1·1
Protoxide iron .	2·50	4·44	6·92	6·25	52·2
Protoxide mang.	0·18	0·42	$\dot{H}$ 1·02	...	...
	99·99	99·99	97·38	99·91	99·6

The general formula for augite is therefore $\dot{C}a^3\dddot{S}i^2+\dot{M}g^3\dddot{S}i^2$; with silica, 55·62; lime, 25·72; magnesia, 18·66, in which $\dot{R}$ consists essentially of $\dot{M}g$ and $\dot{F}e$. The variety under *e* is interesting as furnishing the first instance of an almost pure iron-augite, $\dot{F}e^3\dddot{S}i^2$. It is in the dark green or black augite that alumina principally occurs to any extent; in some varieties it amounts to nearly 7 per cent. Scheerer has shown that it constantly replaces a corresponding amount of silica. Augites are generally either magnesia-lime augites, or lime-iron augites; manganese, however, is frequently present, and all may occur together.

In imbedded and attached crystals and columnar, in fibrous and granular masses.

LOCALITIES.—*England.* Durham; Teesdale, with olivine, in basalt.

Wales.—Anglesea; in various trap-dykes. Carnarvon; near Bangor, in trap. In a steatitic rock at the top of Moel Shabod or Siabod, also on summit of Penmaen Mawr.

Scotland.—Argyll; in the islands of Canna, Mull and Rum, in crystals and crystalline masses in basaltic rocks. Bute; in the Island of Arran. In dark green crystals, in trap, in Skye. Edinburghshire; on Arthur's Seat, in basalt. Fife; in acicular crystalline masses, of a black colour, at [illegible] lime-quarry, near Raith. In Inchkeith, crystals in basalt. Inverness.—in Skye, in crystals and crystalline masses in basalt. In Harris, the greyish-white variety called *Sahlite* is said to occur. Orkneys; in Rousay, in distinct crystals in porphyry. M*bs*; M*abs*. In limestone, in the Island of Tiree.

Ireland.—Antrim; in large, perfect, black crystals at Portrush, with Faroelite. At Fairhead, crystals larger and less perfect. At Agnew's Beacon. With olivine, in coarse greenstone, at Culfeightown and Tor Head. At Ramoan. Derry: at Tullyreagh, in coarse greenstone, with olivine. Tyrone; in the singular dyke near Clogher.

The name augite is derived from *αὐγή*, *brilliancy*.

70. BRONZITE, *Phillips*. Diallage (in part). Schiller-spath, *Mohs*. Augite (in part).

Monoclinic. Isomorphous with augite. Cleavage very perfect parallel to *a*; traces in two other directions; structure curvo-lamellar. Translucent on edges. Lustre pearly metallic, or bronze-like, on the face of principal cleavage. Colour clove-brown, ash-grey, pale green. H. 5·5; Gr. 3·4.

Melts with great difficulty before the blowpipe; is not acted on by acids.

A specimen from the Tyrol gave Köhler—

Silica	56·81
Alumina	2·07
Magnesia	29·68
Lime	2·19
Protoxide of iron	8·46
Protoxide of manganese	0·62
Water	0·84
	100·67

$\dot{R}\ddot{S}i$; where $\dot{R}$ is magnesia and protoxide of iron.

In imperfect imbedded crystals; massive in granular aggregations.

Said to occur in Cornwall, at Coverach Cove, near the Lizard, of a dark brown colour, in serpentine. According to Jameson, at Glen Tilt, in Perthshire, in a syenitic rock. In the Isle of Skye in greenstone, and similarly in small shining laminæ at Benenagh, Magilligan in Londonderry.

71. HYPERSTHENE, *Phillips, Hauy*. Schiller-spath (in part).

Monoclinic. Isomorphous with augite. Has three cleavages: *a*, perfect; *b* M, imperfect. Fracture uneven. Opaque. Translucent on edges. Lustre pearly on *a*. Surface of fracture resinous. Colour greyish or greenish-black, dark green, sometimes copper-red on the most perfect cleavage. Streak greenish-grey. Very tough. H. 6·0; Gr. 3·4.

Before the blowpipe melts more or less readily into a greenish-black glass, which is frequently magnetic. Readily soluble before the blowpipe with borax, forming a greenish glass, but acted on by acids.

Analysis, by Muir, of hypersthene from Skye:—

Silica	51·35
Magnesia	11·09
Lime	1·84
Protoxide of iron	33·92
Water	0·50
	98·90

$\dot{R}\dddot{Si}$; where $\dot{R}$ is protoxide of iron and magnesia, with sometimes lime or protoxide of manganese.

In crystals and crystalline, in granular masses, and as a constituent of several rocks, as in hypersthene rock along with Labradorite; with Labradorite and chlorite in *diabase*; and it also occurs in *euphotide* or *gabbro*.

Localities.—*England*. It is said to occur near the Lizard in Cornwall, as at Coverack Cove, in serpentine. In Radnorshire. ?

Scotland.—At Portsoy in Banffshire; near Aberdeen; in the Island of Rum; at Scavig Loch, Strathquarry, and the Cuchullin Hills in the Island of Skye, where it is used for ornamental purposes after being cut and polished.

Ireland.—In the parish of Termonmaguirk, Co. Tyrone, of a dark green or greyish-black colour, and having a strong metallic lustre, occurring in crystalline concretions of some size. At Craig, parish of Derryloran, in Londonderry, where it passes into a greyish-green diallage rock.

72. DIALLAGE, *Phillips, Hauy*; Schiller-spath, *Hauy*. Augite (in part).

Monoclinic. Isomorphous with augite. Cleavage in two directions, one perfect. Fracture uneven, splintery. Opaque. Translucent in thin plates. Lustre in plane of principal cleavage silky, inclining to metallic. Colour grey, brownish-grey or greenish. H. 4·0; Gr. 3·25.

Before the blowpipe melts easily into a greyish-green enamel. Not acted on by acids.

A specimen from Baste gave Köhler—

Silica	52·89
Alumina	2·70
Magnesia	17·68
Lime	17·40
Protoxide of iron and manganese	8·41
Water	1·06
	100·14

$\dot{R}\dddot{Si}$; where $\dot{R}$ is magnesia, lime and protoxide of iron.

Occurs in imperfect crystals; lamellar, and sometimes forming a constituent of rock (diallage rock); usually occurs with serpentine.

Localities.—Cornwall; with serpentine at Coverack Cove, St. Keverne, and at Gwenter, all near the Land's End (where

Schiller-spar has, perhaps rather indiscriminately, been confounded with diallage, Saussurite and bronzite).

Scotland.—Aberdeenshire; in the parish of Towie; in serpentine at Towenrieff in the parish of Auchindoir; at Belhelvie, and on the Alic Hills. Ayrshire; in large crystals, with serpentine and hornblende, near Ballantrae, at Landelfoot. At Ailsa Craig. Edinburghshire; at Craig Lockart; in Fifeshire and Dumbartonshire, occasionally in the greenstone rocks. Banffshire; with serpentine at Portsoy. On the east coast of Balta, one of the Shetlands; and very distinctly crystallized in Uya near the Island of Unst.

Note.—Bronzite, hypersthene and diallage, are all augites, but for the sake of convenience we give them separate headings.

73. BABINGTONITE, *Levy.*

Anorthic. One cleavage very perfect; striated in a vertical direction. Fracture imperfect conchoidal. Translucent on edges. Lustre vitreous. Colour black, dark-green. Brittle. H. 5·5 to 6·0; Gr. 3·35 to 3·40.

Fuses easily with the blowpipe to a black magnetic bead. With borax yields a clear amethyst-coloured enamel, which becomes green in the reducing flame.

Analyses: *a*, from Arendal, by Arppe; *b*, by R. D. Thomson:—

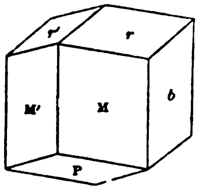
	a.	*b.*
Silica	54·4	47·46
Alumina	0·3	6·48
Lime	19·6	14·74
Magnesia	2·2	2·21
Protoxide of iron	21·3	16·81
Protoxide of manganese	1·8	10·16
Loss	0·9	1·24
	100·5	99·10

Formula, $3\dot{C}a\ddot{S}i + \dot{F}e^3\ddot{S}i^2$; with silica, 54·75; protoxide of iron, 24·99; lime, 20·26.

In this country it has hitherto only been found in one of the Shetlands; it occurs in large irregular laminated crystals of a greenish-black colour, engaged in white quartz.

74. HORNBLENDE, *Phillips*. Amphibole. Actinolite. Tremolite. Asbestus. Amianthus. Anthophyllite. Hemi-prismatic Augite-spar, *Mohs*.

Oblique. Cleavage very perfect parallel to M (more so than in augite); traces parallel to *b*. The faces *m, a, b* sometimes striated, frequently rough. Fracture imperfect conchoidal. Translucent, opaque. Lustre vitreous. Colour various shades of brown, reddish-brown, black, grey, green, yellow. Brittle. H. 5·0 to 6·0; Gr. 2·9 to 3·4.



M M'	124°	30'
M P	103	12
M *b*	117	45
b r	105	46
r r'	148	30

Before the blowpipe melts with intumescence into a greyish-green or black bead. The fusibility increases with the proportion of iron present. Slowly dissolves in borax.

Analyses: *a, black hornblende,* crystallized, from Pargas, by Hisinger; *b, brown hornblende,* from Wetterau, by Bonsdorff; *c, fibrous asbestus,* from Tarantaise, by Bonsdorff; *d, white tremolite,* from Wermland, by Bonsdorff; *e, mountain leather,* from Strontian; *f, mountain cork,* Piedmont; *g, anthophyllite,* from Canada East, by Thomson:—

	a.	b.	c.	d.	e.	f.	g.
Silica	47·62	42·24	58·20	59·75	57·65	57·75	57·60
Alumina	7·38	13·90	0·14	...	9·50	1·95	3·20
Magnesia	14·81	13·74	22·10	25·00	2·06	10·85	29·30
Lime	12·69	12·24	15·55	14·13	10·00	14·05	3·55
Protoxide of iron .	15·78	14·59	3·08	0·50	5·80	18·90	2·10
Protox. manganese	0·32	0·33	0·21	...	...	1·85	...
Hydrofluoric acid .	...	...	0·66	0·94	...	...	...
Water	...	...	...	0·10	?	...	3·55
	98·60	97·04	99·94	100·42	?	105·35(?)	99·30

Formula, $\dot{R}\overline{Si} + \dot{R}^3\overline{Si}^2$, where $\dot{R}$ represents lime and protoxide of iron, and $\dot{R}^3$ magnesia, protoxide of iron or protoxide of manganese.

The green and black varieties contain sometimes nearly 15 per cent. of alumina, which therefore replaces silica without disturbing the crystalline form. Some varieties contain nearly 2 per cent. of hydrofluoric acid. Varieties containing 20 per cent. of iron affect the magnetic needle.

It occurs in attached and imbedded crystals, also fibrous, columnar, granular, and disseminated; it also forms an essential ingredient of syenite, greenstone, and hornblende-slate; and is of pretty frequent occurrence in granite and basalt.

Localities.—*England.* Cornwall; at Five Lanes near Launceston, and occasionally near St. Just.

Worcestershire; at the north side of the Malvern Hills.

Scotland.—Aberdeenshire; in rough lamellar crystals. Banffshire; at Portsoy. Ayrshire; of a dark green colour with diallage and serpentine. In the Island of Iona, in granular black concretions. Good crystals occur near Ben Feoul, in Coll, Hebrides. Shetlands; at Colafirth Voe; in Papa Stour; black and massive on the bank of the Nithister, in Fetlar; plentifully in the cliffs on the north-east side of Balta Island.

Ireland.—Kerry; at Killala. Londonderry; at Slieve Gallion in altered porphyry, and distinctly crystallized. Wicklow; radiated at Killiskey; crystallized and massive, of a dark-green colour, at Kilranelagh. Wexford; with copper ore and felspar.

Tremolite or *actinolite* are synonymous names for the glassy and fibrous varieties of hornblende. The fibres are usually slightly flexible, presenting the faces M and *b*; colour various shades of green, grey, and white. These fine fibres, examined by polarized light, exhibit a gorgeous spectacle. [The mineral prepared for the polarizing microscope is to be had of Mr. Darker, 9 Paradise Street, Lambeth, London.] *Actinolite* also occurs granular and promiscuously fibrous.

LOCALITIES.—*England.* Cornwall; at Huel Unity, St. Day; Botallack mine, St. Just; the Lizard; the Cheesewring near St. Cleer; near St. Keverne and St. Ives; Marazion; at Cadgwith Point; Clikor Tor; Cape Cornwall; Huel Owls; Duforth, west of Charleston near St. Austell; at Fowey Consols in Tywardreath, in quartz; in greenstone rocks between East Crofty and Pool near Redruth; of a white colour in the cliffs beneath Acton Castle in Perranuthnoe; and at the Consolidated mines, 320 fathoms deep.

Carnarvonshire; in amygdaloid at Caradoc Caer. In Anglesea.

In Cumberland, near the Bowder-stone in Borrowdale.

Scotland.—Argyleshire; near Inverary. Banffshire; at Portsoy. Fifeshire; at Inchcolm. Aberdeenshire; in the parish of Leslie and Towie, and at Tyre Bagger (? Tyrie). Perthshire; at Glen Tilt, white and silky. Inverness-shire; at Eilan Reach, Glenelg, of a pale-green colour. In the Hebrides; in the Islands of Lewis, Harris, Orange and Steat. Shetlands; of a green colour and very fine at Hillswickness Point; in Unst, at Swinaness; of a dark green colour in Papa Stour; and in splendid dark-green fibrous masses, two feet thick, at the banks of the Nithister in Fetlar.

Amianthus is of a white colour, occurring in delicate fibres, and ranging between tremolite and asbestus.

In Cornwall, near Liskeard and Lizard Point.

Scotland.—At Portsoy in Banffshire; at Towenrieff, parish of

Auchindoir, in Aberdeenshire; at Glenelg in Inverness-shire. With diallage on the east coast of Balta Island near Unst, and at Kleber Gio, peninsula of Fiedeland, in the Shetlands.

Anthophyllite.—A variety of tremolite; fine columnar, or made up of acicular fibres of a greyish-brown colour; lustre sub-metallic when not weathered. Sp. Gr. 3·0.

Occurs at Girvan in Ayrshire, in fibro-columnar and radiating masses of a greyish-brown colour, sectile and rather weathered, and exactly similar to the *hydrous anthophyllite* of Thomson, from New York Island; specimens, however, from that locality have recently been re-examined by Messrs. Smith and Brush, who find only 2·26 per cent. of water instead of 11·45, as determined by Thomson: it is described by Dana as an altered asbestiform actinolite.

Asbestus occurs at the Lizard; St. Cleer, Goonhilly Downs, and near Liskeard in Cornwall. At Portsoy in Banffshire; at Glenelg in Inverness; at Swinaness, Balta, and Fetlar, in the Shetlands. Near Strabane in Tyrone; and at Bloomfield, parish of St. John's, Wexford, in Ireland.

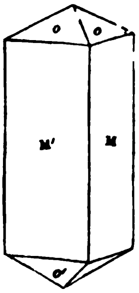
Wood-cork or *Rock-cork* is a variety in which the particles present a loose felt-like texture; it is sectile, and is capable of floating in water; it occurs near the Lizard Point, occasionally, in Cornwall; at Leadhills in Lanark; at Portsoy in Banffshire; in conglomerate at Kinneff in Kincardineshire; on the Alic Hills, and at Kildrummy in Aberdeenshire.

Mountain-leather occurs in flat flexible dirty-white or light-brown masses, having an interwoven fibrous structure and much resembling leather; it is very meagre to the touch. It occurs at Strontian in Argyleshire; at Wanlock Head in Dumfriesshire; and near the Lizard Point in Cornwall. At Aghanloo and at Slieve Gallion in Londonderry; at Coagh, and at Curley Hill in Tyrone.

Mountain-wood, or *ligniform asbestus,* is somewhat harder than the two last; its colour generally dirty-white or brown; slightly fibrous and curved, or presenting a membranous wood-like structure. It occurs with serpentine in the parish of Auchindoir, in Aberdeenshire; near Portsoy in Banffshire along with the preceding varieties; and at Glen Tilt in Perthshire.

75. NATROLITE.—Natrolite, *Dana*; Natrolith, *Haidinger*, *v. Kobell*, *Naumann*; Mesotype, *Brooke* and *Miller*, *Phillips*, *Hauy*; Zeolith, *Hausmann*; Galactite, *Haidinger*; Lehuntite, *Thomson*.

Prismatic. Primary form a right rhombic prism. Cleavage M perfect. Fracture uneven, conchoidal. Transparent, translucent. Lustre vitreous. Colourless, greyish-white, yellowish, reddish (the same crystal being frequently white in one part and red in another), green (Bowling). Streak white. Not pyro-electric. Brittle. H. 5·0 to 5·5; Gr. 2·17 to 2·26.



M M'	91° 00'
M *o*	116 40
o o	143 20

In the matrass yields water. Before the blowpipe becomes cloudy, and then, with strong and persistent reaction of soda, melts quietly and without intumescence to a transparent bead. Decomposed in hydrochloric acid, with the formation of a jelly of silica. Readily soluble in oxalic acid, with the occasional separation of small quantities of lime.

Analyses of natrolite: *a*, from Auvergne, by Fuchs; *b*, from Bishoptown, by Scott; *c*, from Antrim, by Thomson; *d*, from

Dumbarton Moor, by Heddle; *e*, from Bowling (green), by Heddle :—

	a.	*b.*	*c.*	*d.*	*e.*
Silica	47·76	47·63	47·56	46·96	48·03
Alumina . . .	25·88	27·17	26·42	26·91	25·26
Peroxide of iron	...	...	0·58	...	...
Soda	16·21	15·12	14·93	12·83	13·97
Lime	...	...	1·40	3·76	2·31
Water . . .	9·31	9·78	10·44	9·50	9·72
	99·16	99·70	101·33	99·96	99·29

$\dot{\mathrm{N}}\mathrm{a}\dddot{\mathrm{S}}\mathrm{i} + \dddot{\mathrm{A}}\mathrm{l}\dddot{\mathrm{S}}\mathrm{i} + 2\dot{\mathrm{H}}$, that is to say, the substance of rhyacolite, with the addition of 2 equivalents of water. The formula requires—silica, 47·86; alumina, 26·62; soda, 16·20; water, 9·32. It differs chemically from scolezite by containing soda instead of lime, and only 2 equivalents of water, whereas the latter contains 3.

Analyses: *a*, by Kengott; *b*, from Glen Farg (white) :—

	a.	*b.*
Silica	46·99	48·24
Alumina	26·84	27·00
Soda	9·68	14·82
Potash	0·45	...
Lime	4·36	0·82
Water	10·56	9·24
	98·88	100·12

c, from Glen Farg (red); *d*, from Campsie; *e*, from Bishoptown (white); *f*, from Bishoptown (pink), all by Heddle; *g*, (*Lehuntite*), by Thomson.

	c.	*d.*	*e.*	*f.*	*g.*
Silica . . .	47·84	47·32	47·60	47·76	47·33
Alumina .	27·11	27·36	26·60	27·20	24·00
Soda . . .	11·30	13·35	15·86	14·28	13·20
Lime . . .	4·31	2·63	0·16	0·93	1·52
Water . . .	10·24	10·39	9·56	9·56	13·60
	100·80	101·05	99·78	99·73	99·65

Heddle thinks that *c* and perhaps *a* may be a distinct compound with the formula $(\dot{\text{Na}}^2\dot{\text{Ca}})\dddot{\text{Si}}^3+3\overline{\dddot{\text{Al}}}\dddot{\text{Si}}+7\dot{\text{H}}$; this requires silica, 47·41; alumina, 26·32; soda, 10·70; lime, 4·79; water, 10·78; and he shows that this formula may be written—

$$2(\dot{\text{Na}}\dddot{\text{Si}}+\overline{\dddot{\text{Al}}}\dddot{\text{Si}}+2\dot{\text{H}})+(\dot{\text{Ca}}\dddot{\text{Si}}+\overline{\dddot{\text{Al}}}\dddot{\text{Si}}+3\dot{\text{H}}),$$ that is to say,

2 atoms of natrolite + 1 atom of scolezite,

a compound the reverse in fact of mesolite.

The *Lehuntite* of Thomson, which at first sight appears to be a natrolite with *three* atoms of water, Heddle states to be merely natrolite with air-cavities (hence the low gravity) lined with minute primary crystals of stilbite, which afford the surplus water, and agree with Thomson's "minute scales."

Natrolite occurs in attached crystals and fibrous or radiating masses in cavities in basalt and trap-rocks, and sometimes in beds and veins in crystalline slate and transition rocks.

LOCALITIES.—*England.* Cornwall; occasionally with Prehnite, between Botallack and Wheal Cock, and at Wheal Carn near St. Just. At Stenna Gwynn near St. Austell.

Staffordshire; in decomposed basalt, in the parishes of Arbuthnot and St. Cyrus.

Scotland.—Dumbartonshire; at Bowling (green) this variety has been sold as *stellite*; Dumbarton Moor; Cochnay and Duntocher. Stirlingshire; at Carbeth in fine specimens. At the Campsie Hills radiated and compact, *galactite**. Renfrewshire; with Prehnite at Bishoptown (*galactite*), in pure acicular crystals several inches long, interlaced into a felty mass, associated with calcite, Greenockite, &c.; at Hartfield Moss. Edinburgh; at the Braid Hills. Fifeshire; in the trap-tuff hill called Blin near Burntisland; at Glen Farg, in well-formed crystals with the form of the figure, of a flesh-red colour and colourless; also compact, reddish or milk-white, constituting Haidinger's *galactite.*

Ireland.—Antrim; at Carn Castle, Upper Glenarm, and at the Little Deer Park near the same place, with calcite in trap, and in delicate silky crystals in amygdaloidal claystone. Occasionally at the Causeway at Ardihannan Cove; at Portrush; at Magee Island near Larne, in fine crystals and radiating masses; at the Cave Hill, Belfast, fibrous and compact, of a pale red, in trap. Londonderry; at Portstewart, with analcime in greenstone; at Magilligan, in delicate tufts. On east side of Down Hill. At Craignashoke, beautifully disposed in cavities in greenstone, with Levyne and analcime.

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* Lately proved by Kengott and Heddle to be natrolite.

The name natrolite is derived from *natrum*, soda, and *λίθος*.

76. SCOLEZITE.—Scolezite, *Brooke* and *Miller, Dana, Beudant*; Needlestone, *Phillips*; Skolezit, *Haidinger, Hausmann, v. Kobell, Naumann.*

Oblique. M M′ 91° 22′. Usually in delicate fibres or needles. Twin crystals common, the twin axis being the main axis of the crystal, the two individuals thus presenting the appearance of a simple crystal. Cleavage M tolerably perfect. Fracture uneven. Colourless, white, greyish, yellowish-white. Lustre vitreous, in fibrous aggregations silky. Transparent to translucent on the edges. Usually pyro-electric in a remarkable degree, the diverging ends of the attached crystals exhibiting negative electricity on an increase of temperature, and the converging ends positive electricity. Brittle. H. 5·0 to 5·5; Gr. 2·2 to 2·3.

In the matrass yields water. Before the blowpipe twists and curls up at first, and then melts readily with phosphorescence to a blebby glass. Completely decomposed by hydrochloric acid, leaving a jelly of silica. Partially soluble in oxalic acid, leaving a residue of oxalate of lime.

Analyses: *a*, from Staffa, by Fuchs and Gehlen; *b*, from Isle of Mull, by Scott.

	a.	b.
Silica	46·75	46·21
Alumina . . .	24·82	27·00
Lime	14·20	13·45
Soda	0·19	...
Water	13·64	13·78
	99·60	100·44

$\dot{\mathrm{Ca}}\dddot{\mathrm{Si}}+\overline{\dddot{\mathrm{Al}}}\dddot{\mathrm{Si}}+3\dot{\mathrm{H}}$; silica, 46·6; alumina, 25·8; lime, 14·0; water, 13·6.

In twin crystals, and masses composed of radiating fibres, in cavities of amygdaloid, basalt, and similar rocks.

LOCALITIES.—*Scotland.* Argyleshire; at Staffa, in trap and basalt, in delicate fibrous tufts of a white colour. In the Isle of Mull, near Loch Sereden (or Screden); also in trap, in long radiating needles, with epidote. In Skye, at Talisker.

Scolezite is a far rarer mineral in Great Britain than natrolite or mesolite.

The name scolezite is derived from *σκώληξ*, *a worm*, with reference to the remarkable manner in which it curls up on exposure to the blowpipe flame.

77. **MESOLITE.**—Mesolith, *Fuchs*; Mesolite, *Heddle*; Harringtonite, *Thomson*. Mealy Zeolite. Lime and Soda Mesotype. Antrimolite, *Thomson*.

According to G. Rose, it may be doubted whether mesolite is entitled to be considered a distinct species, inasmuch as it appears to consist essentially of only soda-scolezites and lime-natrolites, the distinction of which it is not at all times an easy matter to establish. Dr. Forster Heddle of Edinburgh has, however, recently endeavoured, and we think successfully, to establish the necessity of considering mesolite a distinct species*. If we consider mesolite as being a combination of two atoms of scolezite and one atom of natrolite, the formula of this compou would be $2(\dot{Ca}\dddot{Si}+\dddot{Al}\dddot{Si}+3\dot{\text{Ħ}})+(\dot{Na}\dddot{Si}+\dddot{Al}\dddot{Si}+2\dot{\text{Ħ}})$, or mo simply $(\dot{Na},2\dot{Ca})3\dddot{Si}+3(\dddot{Al},\dddot{Si})+8\dot{\text{Ħ}}$; which would give,—

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* See Philosophical Magazine for January 1857, "On Mesolite and Faröelite," by Dr. Heddle.

Silica	46·95
Alumina	26·06
Lime	9·49
Soda	5·30
Water	12·20
	100·00

Now this would appear to be the actual composition of ma British, as well as foreign mesolites, as will be seen by referen to the subsequent analyses, and we think ourselves justified retaining this as a true species, distinct not only from scolezi or natrolite, but also from Faröelite. *Mesolite* occurs usual in delicate interlacing crystals, which, when crushed, beco the *mealy zeolite* of some authors; also in radiating colourle crystals; colour dead white; lustre vitreous, never pearly as Faröelite. Pyro-electric like scolezite; and other physical ch racteristics similar. M on M′=91° in the crystals from K more. H. 5·0 to 5·5; Gr. 2·25.

LOCALITIES.	$\dddot{Si}$	$\dddot{Al}$	$\dot{Ca}$	$\dot{Na}$	$\dot{\text{Ħ}}$
1. Giant's Causeway	48·88	26·36	7·64 2·46 $\dot{Mg}$	4·20	12·
2. Kinross	48·03	26·64	5·47	8·32	10·
3. Storr, Skye . .	46·72	26·70	8·90	5·40	12·
4. Talisker, do. . .	46·71	26·62	9·08	5·39	12·
5. Kilmore, do. . .	46·26	26·48	10·00	4·98	13·
6. Faröe	46·80	26·50	9·87	5·40	12·
7. Iceland, *feathery*	46·78	25·66	10·06	4·79	12·
8. Tyrol	46·04	27·00	9·61	5·20	12·
9. Niederkirchen .	46·65	27·40	9·26	4·91	12·
10. Iceland	47·46	25·35	10·04	4·87	12·
11. *Harringtonite* .	44·96	26·85	11·01	5·56	10·
12. *Harringtonite* .	45·07	26·21	11·32	3·75	12·
13. *Antrimolite* . .	47·07	26·23	9·88	4·89	12·

Analyses:—1 and 2, by Thomson. 3, 4 and 5, by Heddle. 6, by Ber lius. 7 and 8, by Fuchs and Gehlen. 9, by Riegel. 10, by Fuc 11, by Thomson. 12, by Kengott. 13, by Heddle.

Localities of mesolite.—*Scotland.* Edinburghshire; near Edinburgh. Kinross-shire; near Kinross. Renfrewshire; at Hartfield Moss. In delicate tufts and mealy at Talisker, Storr, Quirang, and Kilmore, all in the Island of Skye; and similarly with chabasite in the Island of Eigg.

Ireland.—Antrim; in fine acicular crystals at the Giant's Causeway. Londonderry; at Down Hill.

Harringtonite of Thomson, which must now be considered merely amorphous mesolite, occurs massive, tough. Colour chalky-white, earthy, opaque. H. 5·25; Gr. 2·21. General chemical characters same as mesolite.

Analyses: *a* and *b*, by Thomson; *c*, by Kengott:—

	a.	*b.*	*c.*
Silica . . .	44·84	44·96	45·07
Alumina . .	28·48	26·85	26·21
Lime . . .	10·68	11·01	11·32
Soda . . .	5·56	5·56	3·75
Water . . .	10·28	10·28	12·93
	99·84	97·66	99·28

Localities of Harringtonite.—*Ireland.* Antrim; in veins and layers half an inch thick, in fine-grained greenstone, at Portrush, and at the Skerries, one mile N.E. of that place. At Magee Island, and at Agnew's Hill five miles west of Larne.

Antrimolite of Thomson occurs in silky fibrous stalactites, white, or stained brown. Fibres radiating from the centre. According to Brooke and Kengott, appears to resemble scolezite in form; the latter says the angle of the prism is 92° 13′, the outer angles being beveled by a prism of 150° 30′. H. 3·7; Gr. 2·1.

Before the blowpipe melts quietly to a white enamel. Decomposed by hydrochloric acid, forming a jelly of silica.

Analyses: *a*, by Thomson, of a specimen from Bengore Head; *b*, by Parry; *c* and *d*, by Heddle:—

	a.	*b.*	*c.*	*d.*
Silica . . .	43·47	43·37	47·07	45·98
Alumina . .	30·26	26·29	26·23	26·18
Lime . . .	7·50	9·58	9·88	10·78
Soda . . .	4·10 (potash)	4·83	4·89	4·55
Water . .	15·32	15·12	12·24	13·00
	100·65	99·19	100·31	100·49

Whatever formula Rammelsberg and Kobell suggest, it is evident from the three last analyses that the potash of Thomson was an error, and that, mineralogically, Antrimolite must now rank as mesolite.

Localities of Antrimolite.—*Ireland.* Antrim; at Ballintoy, investing pyramidal crystals of yellow calcite, or disposed on chabasite in the cavities of amygdaloid; sometimes studded with rhombs of brown calcite.

78. FARÖELITE.—Faröelite, *Heddle*; Mesole, *Haidinger*, *Rose*, *Dana*.

Occurs either in implanted globules or spheres with an internal fibrous and radiated crystalline structure, or stalactitic; sometimes as a mammillated coating. Has one pearly cleavage. Colour white, bluish, yellowish, greyish. Fuses with effervescence to a frothy enamel; gelatinizes in hydrochloric acid. H. 3·5; Gr. 2·35.

Analyses: *a*, from Faröe, by Berzelius; *b*, from Skye, by Thomson; *c*, from Storr; *d*, from Portree; *e* and *f*, from Uig, in Skye, all by Dr. Heddle:—

	a.	*b.*	*c.*	*d.*	*e.*	*f.*
Silica .	42·60	40·33	41·32	41·20	43·17	43·21
Alumina	28·00	29·00	28·44	30·00	29·30	29·03
Lime .	11·43	12·12	11·54	11·40	9·82	10·35
Soda .	5·63	5·33	5·77	4·38	5·33	5·16
Water .	12·70	13·22	13·26	13·20	13·20	12·46
	100·36	100·00	100·33	100·18	100·02	100·21

The similarity of these results evidently indicates that Faröelite may rank as a distinct species, and Dr. Heddle suggests as a formula $(\acute{\mathrm{C}}\mathrm{a}^2, \dot{\mathrm{N}}\mathrm{a})\dddot{\mathrm{S}}\mathrm{i}^2+3\dddot{\mathrm{A}}\mathrm{l}\overline{\mathrm{S}}\mathrm{i}+8\dot{\mathrm{H}}$, which gives the following proportions :—

Silica	42·45
Alumina	28·27
Lime	10·29
Soda	5·75
Water	13·24
	100·00

The sole difference between Faröelite and mesolite therefore is one equivalent of silica; but the mineralogical distinctions are also well marked. See 'Philosophical Magazine' for January 1857, for a paper on Faröelite and Mesolite by Dr. Heddle, who gives the following Table of chemical formulæ for this family of zeolites :—

Natrolite. . .	$\dot{\mathrm{N}}\mathrm{a}\ \dddot{\mathrm{S}}\mathrm{i}+\ \dddot{\mathrm{A}}\mathrm{l}\dddot{\mathrm{S}}\mathrm{i}+2\dot{\mathrm{H}}$
Fargite ? . . .	$(2\dot{\mathrm{N}}\mathrm{a},\ \acute{\mathrm{C}}\mathrm{a})3\dddot{\mathrm{S}}\mathrm{i}+3(\dddot{\mathrm{A}}\mathrm{l}\dddot{\mathrm{S}}\mathrm{i})+7\dot{\mathrm{H}}$
Mesolite . . .	$(\dot{\mathrm{N}}\mathrm{a}, 2\acute{\mathrm{C}}\mathrm{a})3\dddot{\mathrm{S}}\mathrm{i}+3(\dddot{\mathrm{A}}\mathrm{l}\dddot{\mathrm{S}}\mathrm{i})+8\dot{\mathrm{H}}$
Faröelite . .	$(\dot{\mathrm{N}}\mathrm{a}, 2\acute{\mathrm{C}}\mathrm{a})2\dddot{\mathrm{S}}\mathrm{i}+3(\dddot{\mathrm{A}}\mathrm{l}\dddot{\mathrm{S}}\mathrm{i})+8\dot{\mathrm{H}}$
Scolezite . . .	$\acute{\mathrm{C}}\mathrm{a},\ \dddot{\mathrm{S}}\mathrm{i}+\ \dddot{\mathrm{A}}\mathrm{l}\dddot{\mathrm{S}}\mathrm{i}+3\dot{\mathrm{H}}$

We have preferred Dr. Heddle's name for this species, as its adoption will do away with the almost identity of its old name with that of the preceding species.

LOCALITIES.—*Scotland.* Isle of Skye; near Talisker, in implanted globules of a beautiful white colour and with a radiated structure, with delicate crystals of transparent Laumonite and small crystals of *tesselite*; at Storr in bluish-white implanted spheres, with feathery mesolite; at Portree in confused white globules; at Uig, lining cavities in trap, in white radiated globules.

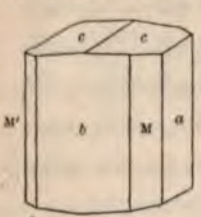
Much the finest specimens, however, are found in the Faröe Islands, where it sometimes occurs in stalactites 3 inches long.

Ireland.—Antrim; at Portrush in greenstone; at Agnew's

Hill; at Black Cave near Larne; at the N.W. of Rathlin Island, in distinct globules and in mammillary coatings, associated with transparent analcime and mesolite. Londonderry; at Magilligan; at Sleive Gallion Carn, in large globules with Gmelinite. At some of these localities mesole occurs in masses composed of small globules that have lost their lustre and radiated structure.

79. THOMSONITE.—Thomsonite, *Brooke*, *Dana*; Comptonite, *Brooke* and *Miller*; Thomsonite, Comptonite, *Phillips*, *Beudant*; Comptonit, *Hausmann*; Thomsonit, *Haidinger*, *v. Kobell*. Scoulerite. Chalilite.

Prismatic. Primary form a right rhombic prism. Cleavage: *a* perfect; *b* less so, but not much. Faces: M striated parallel to their intersections with *a* and *b*. Fracture uneven. White, inclining to yellowish or brownish-red. Transparent to translucent. Lustre vitreous, sometimes inclining to pearly. Brittle. Streak white. H. 5 to 5·5; Gr. 2·3 to 2·4.



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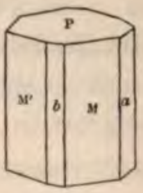

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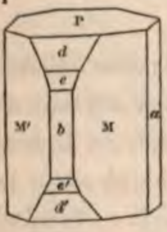


3

M P	90° 00′
M M′	90 40
M *a*	134 40
M *b*	135 20
P *b*	90 00
b a	90 00
b d	166 30
b e	172 50
c c	177 32

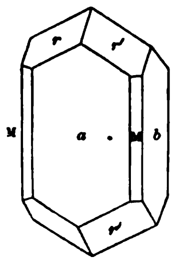
cc=177° 35′ according to Naumann; but Mr. Brooke says this angle varies from 175° to 178°.

In the matrass yields water. Intumesces before the blowrocks, where they rest on the porphyry of the Sandy Brae district in Antrim. Also at Tirdree Hill. In Londonderry, rarely; at Magilligan, very compact; and at Down Hill.

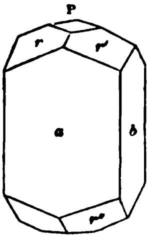
The Ordnance Collection of Minerals in Dublin contains an interesting series of specimens, showing the relation manifestly subsisting between Thomsonite, Scoulerite and chalilite.

80. STILBITE.—Stilbite, *Brooke* and *Miller*, *Dana*, *Phillips*, *Beudant*; Stilbit, *Haidinger*; Desmin, *Breithaupt*, *Hausmann*, *Naumann*, *Rose*; Sphærostilbite, *Beudant*.

Prismatic (according to Breithaupt oblique). Primary form a right rhombic prism. The polar edges of the pyramid, according to Köhler, 119° 15′ and 116°. Cleavage highly perfect parallel to *a*, parallel to *b* imperfect. Colourless, white, also coloured red, grey, yellow and brown. Translucent to transparent on the edges. Lustre somewhat pearly on *a*, other planes vitreous. Fracture uneven. Brittle. Streak white. H. 3·5 to 4; Gr. 2·1 to 2·2.



1



2

P *a*	90° 00′
a b	90 00
M*a*	132 52
a r	123 00
P *r*	132 00
b r	120 22
r r′	119 16
r′ r″	114 00

British combinations: *a b* P; *a b r*; *a b r* P; *a b r* P M; *a b r* M.

In the matrass yields water. Phosphoresces before the blowpipe, and fuses with great intumescence into a blebby glass. Completely decomposed by hydrochloric acid, leaving the silica in the state of a slimy powder.

Analyses: *a*, from the Faröe Islands, by Moss; *b*, from Iceland, by Fuchs and Gehlen; c, from Niederkirchen, in Rhenish Bavaria, by Riegel:—

	a.	b.	c.
Silica . . .	56·93	55·07	58·33
Alumina . .	16·54	16·58	16·66
Lime . . .	7·55	7·58	7·16
Soda . . .	1·54	1·50	1·62
Potash . . .	0·20	...	$\ddot{F}e$ 0·26
Water . . .	17·79	19·30	14·50
	100·55	100·03	98·53

$\dot{C}a\overline{Si}+\overline{\overline{Al}}\,\overline{Si}^{3}+6\dot{H}$; silica, 57·98; alumina, 16·13; lime, 8·94; water, 16·95; a small portion of the lime, in some instances as much as 3 per cent., being usually replaced by soda or potash, or a mixture of both.

In attached crystals and massive, chiefly in the cavities of amygdaloidal rocks, with other zeolites and calcite.

Localities.—*England.* Cornwall; with Prehnite between Botallack and Wheal Cock.

Scotland.—Aberdeenshire; plumose, at Call Hill near Aberdeen. Argyleshire; in amygdaloid in Staffa. In Kerrera Island, of a red colour, in fissures of the greywacke schist near the trap. In grouped crystals in Island of Canna. Bute; at Garbh-Corre-du in Isle of Arran, of the form of figure 1 (with the exception of face M), in granite. Dumbartonshire; of a red colour at Long Craig, Dumbarton Muir, well crystallized, in the form of figure 1. In Kincardine, at Kineff, in basalt. In the Island of Staffa. Inverness; with chabasite at Storr in Skye; also at Talisker, in the same island, in small crystals of the form of figure 2, upon mealy zeolite. Fine grouped crystals occur likewise at other Skye localities, as, for instance, at Quirang and at Snizort; *a b* P; *a b r*; *a b* P *r*. Kincardineshire; at Kincardine, in large sheaf-like aggregations. Perthshire; at Glen Farg. Renfrewshire; of a white colour at Kilmalcolm, crystallised, and also in radiating groups. The combination a b r is met with there. At Port Glasgow, at Loch Winnoch. Stirlingshire: at Campsie and Fintry in very fine red crystals of the form of figure 2, in parallel aggregations, associated with crystals of red Heulandite, which latter are at once to be distinguished from the associated red stilbite by the superior pearliness of the plane b in Heulandite. At Kilpatrick also with the forms a b r; a b P r; a b P r M. At Kilmacolm, in yellowish crystals, a b r; a b P r.

Ireland.—Antrim; with chabasite, in geodes at the Causeway. At Ballintoy; cream-coloured, in sheaf-like aggregations, occasionally finely crystallised with Heulandite. Aggregated and globular, white, at Portrush. In small white crystals with apophyllite, at Bengore Head. At Ramoan, at the [illegible] Hill near Ballycastle; at Bruce's Castle, on Rathlin Island, in drusy cavities, in greenstone; similarly at Dunluce Castle, near the Causeway. Down. In the granite of the Mourne Mountains in small white sheaf-like crystals, resembling the Arran specimens. The stilbite from this locality is said to contain magnesia, a substance that has been already shown to be present in the stilbite from the neighbourhood of Christiania, and from Gustavsberg in Jaemtland. Fermanagh; in a trap dyke in this county in sheaf-like bundles, coated with peroxide of iron. Londonderry; in snow-white crystals in flinty jasper, in the upper part of the chalk rocks at Donald's Mountain.

The name stilbite is derived from στίλβη, *lustre*.

According to Heddle, the sphærostilbite of Beudant is merely stilbite in the form of minute primary crystals disposed upon delicate radiating tufts of mesolite, the presence of which determines the spherical form, causes the gelatinization in acids, and accounts for the slight variation in composition. The hypostilbite he considers a somewhat similar substance.

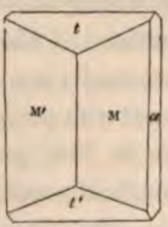
Analyses: *a*, from Faröe, by Beudant; *b*, from Skye, by Heddle:—

	a.	*b.*
Silica	55·91	56·54
Alumina	16·61	16·43
Lime	9·03	8·90
Soda	0·68	0·46
Water	17·84	17·05
	100·07	99·38

Occurs in Skye, at Storr, in minute spheres, sprinkled over Faröelite, and at Quirang in spheres the size of a pea, with other zeolites.

81. **EPISTILBITE.**—Epistilbite, *Brooke* and *Miller, Phillips, Beudant*; Epistilbit, *Haidinger, Hausmann, v. Kobell, Naumann, Rose.*

Prismatic. Twins; twin-face M. Cleavage highly perfect parallel to *a*. Lustre pearly upon cleavage plane, on other faces vitreous. Fracture uneven. Colourless, white, occasionally with a tinge of yellow or pink. Streak white. Brittle. Transparent to translucent on the edges. H. 3·5 to 4; Gr. 2·24 to 2·25.



M M′	135° 10′
M *a*	112 25
t t′	109 46

Combinations: M *t*; M *a t*.

In the matrass yields water. Before the blowpipe melts with intumescence into a blebby enamel, which becomes blue with solution of cobalt. Decomposed by concentrated hydrochloric acid, leaving silica in powder. After ignition is not decomposed by acids.

Analyses: *a*, *b*, by Gustav Rose; *c*, by Beudant, all from Iceland:—

	a.	b.	c.
Silica . .	58·59	60·28	58·61
Alumina .	17·52	17·36	17·03
Lime . .	7·56	8·32	8·21
Soda . .	1·78	1·52	1·20
Water . .	14·43	Loss as water, 12·52	13·80
	99·98	100·00	98·85

$(\dot{\mathrm{C}}\mathrm{a},\dot{\mathrm{N}}\mathrm{a})\ddot{\mathrm{S}}\mathrm{i}+\dddot{\mathrm{A}}\mathrm{l}\dddot{\mathrm{S}}\mathrm{i}^3+5\dot{\mathrm{H}}$; silica, 59·0; alumina, 17·5; lime, 9·0; water, 14·5; a small portion of the lime being replaced by soda.

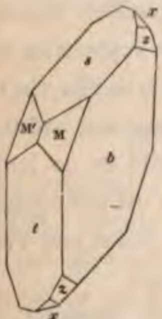
The above formula is likewise that of Heulandite, and this would seem to support the idea of Levy, that the forms of these two substances are identical; yet such a conclusion can only be arrived at by a very forced process, and by disregarding not unimportant differences of angles. Planes of epistilbite are assumed to be dissimilar whose appearance is perfectly similar, and are considered to accord with certain planes of Heulandite, which in the latter are entirely different in their appearance. The symmetry of the faces in epistilbite is distinctly prismatic, not oblique, as is the case with Heulandite. Moreover, Heulandite and epistilbite occur associated together in one and the same cavity, and this is not usually observed in varieties of the same species. The union of Heulandite and epistilbite therefore does not seem to be warranted, while on the supposition that the composition of epistilbite and of Heulandite is similar, the two substances would be looked upon as heteromorphous, and their occurrence in common in the same cavity would be no longer exceptional, inasmuch as heteromorphous bodies not unfrequently occur together, as shown in the instances of garnet and Vesuvian, pyrites and marcasite, Brookite and anatase.

The above formula does not, however, only represent the constitution of epistilbite and Heulandite: it is the expression likewise of the composition of Brewsterite. As the proto-atomic bases of these three minerals can replace each other, the three species are heteromorphous, and the substance $\dot{R}\dddot{Si} + \dddot{Al}\dddot{Si}^3 + 5\dot{\text{Ħ}}$ is consequently trimorphous.

Localities.—*Scotland.* This rare species was discovered in the Isle of Skye in 1852, by Mr. James Russell of Chapelhall, Airdrie. It occurs in small crystals of a pale flesh-colour, transparent, brilliant, and very perfect, in cavities in amygdaloid. But two specimens were found; they are in Mr. Greg's collection. The form is shown in the figure. The face *a* is barely perceptible.

82. HEULANDITE.—Heulandite, *Brooke* and *Miller*, *Dana*, *Phillips*, *Beudant*; Heulandit, *Haidinger*; Stilbit, *Hausmann*, *Naumann*, *Rose*.

Oblique. Primary form an oblique rhombic prism*. Cleavage very perfect parallel to *b*. Fracture conchoidal, uneven. Brittle. Lustre on P pearly, on other planes vitreous. Colourless, white, but frequently coloured, especially flesh-red to tile-red, also occasionally yellowish-grey to hair-brown and olive-brown. Transparent to translucent on the edges, and opaque. H. 3·5 to 4; Gr. 2·1 to 2·2.



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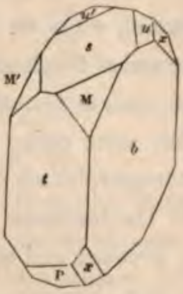

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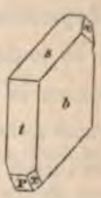


3

b t	90°	00′
b P	90	00
b s	90	00
b M	111	58
b u	106	32
b x	131	40
b z	137	55
P*s*	114	00
P*t*	116	20

---

[*] According to Breithaupt it belongs to the anorthic system, an opinion to which Naumann is inclined to assent, from the manner in which not unfrequently the crystals are disposed after the nature of twins.

The combinations observed in Campsie crystals are: M*bstz*; *bst*P*x*; M*bstzx*; M*bst*P*ux*. The plane *z* does not appear to have been noticed before. According to Dr. Heddle, M*bsct*, ...*x*, ...*u*, ...*ux*, at Storr; at Kilpatrick Hills and Campsie, *bst*; M*bsct*, ...*x*, ...*u*, ...*ux*; Kilmalcolm, *bts*P, *bts*PM; Balta, *bst*P.

In the matrass yields water, exfoliates before the blowpipe, and fuses with intumescence into a white enamel. Readily soluble in hydrochloric acid, leaving a gelatinous powder of silica.

Mean of two analyses of Heulandite, probably from Iceland, by Damour:—

Silica	59·85
Alumina	16·15
Lime	7·55
Soda	1·16
Potash	0·67
Water	14·33
	99·71

$\dot{\mathrm{C}}\mathrm{a}\dddot{\mathrm{Si}}+\dddot{\mathrm{A}}\mathrm{l}\dddot{\mathrm{Si}}^3+5\dot{\text{Ħ}}$.

The constitution of this mineral, as deduced from the above analysis, is simpler, and consequently more probable than that indicated by the analyses of Walmstedt and Thomson. The above formula, it will be observed, agrees very closely with that of G. Rose for epistilbite, and also with that for Brewsterite, as deduced by Rammelsberg from the analyses by Thomson and Connel, the proto-atomic bases consisting in Heulandite and epistilbite of lime and a portion of soda, and in Brewsterite of strontia and baryta. Since, however, these bases are isomorphous, the substance $\dot{\mathrm{R}}\dddot{\mathrm{Si}}+\dddot{\mathrm{A}}\mathrm{l}\dddot{\mathrm{Si}}^3+5\dot{\text{Ħ}}$ affords an instance of trimorphism.

Occurs in attached crystals and in layers and granular masses, usually in cavities of amygdaloidal rocks, with stilbite and other zeolites; less frequently in slate rocks.

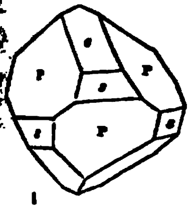
Localities.—*Scotland.* Dumbartonshire; in red crystals at Long Craig, Dumbarton Muir. In neighbourhood of Old Kilpatrick. Renfrew; at Kilmalcolm in colourless crystals with the form M *b s c t*. Forfar; between Bewie and Stonehaven. Lanarkshire; at Stocking Moor near Glasgow. Stirlingshire; in very fine brick-red crystals at Campsie Hills, with quartz, chlorite and calcite. At Carbeth. It is said to occur also at Glen Farg, in Perthshire, and near Loch Humphrey. Rarely, in small brick-red crystals, at Melschter, Waas, Orkneys, according to Dr. Heddle; occasionally at Storr, in Skye, crystals colourless and with much lustre. At the Geldrens, and in large red crystals at Ballygroggan, near the Mull of Cantyre. In Balta Island, Shetlands, in small bright yellow crystals, *b s t* P; in a vein of calc-spar in serpentine at the south end of the island.

Ireland.—Antrim; at Portrush, occasionally in cavities in greenstone and trap. At the Giant's Causeway, well crystallized. At Ballintoy, with stilbite. Similarly at May Island. In small crystals of an olive-brown, and remarkable for their lustre, in porphyry, at Sandy Braes.

This species was first distinguished from stilbite by Mr. Brooke, and named by him in compliment to Mr. Heuland, to whom for many years British mineralogists have been so much indebted.

83. CHABASITE.—Chabasie, *Brooke* and *Miller*, *Phillips*, *Hauy*; Chabacit, *Hausmann*, *Haidinger*; Chabasit, *Naumann*, *v. Kobell*, *G. Rose*; Glottalite, *Thomson*.

Rhombohedral. Cleavage P tolerably distinct. The faces P, *e* striated parallel to their intersections with each other. The crystals often united in druses. Fracture uneven. Colourless, white, grey, occasionally pinkish, reddish, yellowish. Lustre vitreous. Translucent to transparent. Streak white. H. 4 to 4·5; Gr. 2·09 to 2·15.



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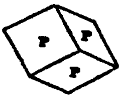

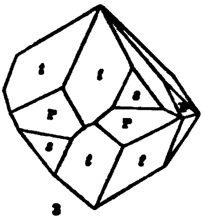

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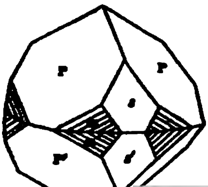

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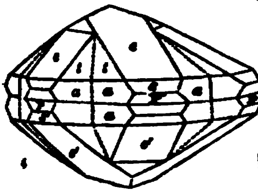

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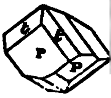
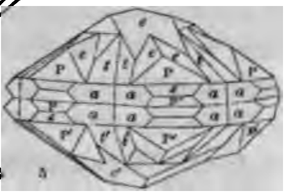
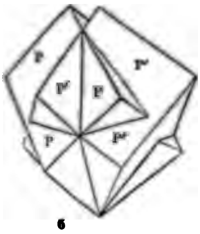



P
P
P'
a
a
a
a
P'
P'
5



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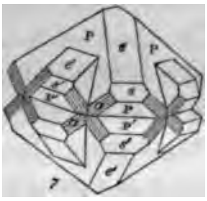
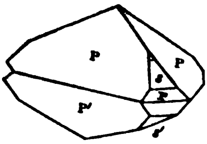




8

PP	94° 46′	P*s*	90° 00′	*ae*	90° 00′	*ss*	72° 52′ ($s\bar{1}11$)
P*a*	132 37	P*t*	155 15	*ao*	90 00	*te*	162 08
P*e*	96 28	*aa*	120 00				

Combinations: P; P*s*; P*e*; P*a*; P*ae*; P*es*; P*as*; *tes*; *ts*; P*sae*; P*est*; *esta*; P*ts*; P*esta*. Twin forms of common occurrence; twin face *o* (see figure 1, Gmelinite).

Before the blowpipe fuses to a spongy enamel imperfectly transparent. In hydrochloric acid completely decomposed, leaving a siliceous jelly.

Analyses: *a*, *b*, from Kilmalcolm, in Renfrewshire, and *c*, from Portrush, in Antrim, by Thomson; *d*, from Kilmalcolm, by Connel; *e*, Parsborough, in Nova Scotia, by Hoffmann :—

	a.	*b.*	*c*	*d.*	*e.*
Silica	48·76	49·20	48·99	50·14	51·46
Alumina . . .	17·44	17·91	19·77	17·48	17·65
Peroxide of iron .	...	...	0·40	...	0·85
Lime	10·47	9·64	4·07	8·47	8·91
Soda	...	...	6·07	...	1·09
Potash	1·55	1·92	...	2·58	0·17
Water	21·72	20·41	20·70	20·83	19·66
	99·94	99·08	100·00	99·50	99·79

$(\dot{\text{C}}\text{a},\dot{\text{N}}\text{a},\dot{\text{K}})^3\dddot{\text{S}}\text{i}^2+3\dddot{\text{A}}\text{l}\dddot{\text{S}}\text{i}^2+18\dot{\text{Ħ}}$, which is the same as the formula of analcime, except that the amount of water is greater. The variety from Parsborough, and a similar one from Gustavsberg in Jaemtland, require however the formula $(\dot{\text{C}}\text{a},\dot{\text{N}}\text{a},\dot{\text{K}})\dddot{\text{S}}\text{i}+\dddot{\text{A}}\text{l}\dddot{\text{S}}\text{i}^2+6\dot{\text{Ħ}}$. In the usual varieties the ratio of the oxygen of $\dot{\text{R}},\dddot{\text{A}}\text{l},\dddot{\text{S}}\text{i}$ and $\dot{\text{Ħ}}$ would be 1 : 3 : 8 : 6, in the latter varieties 1 : 3 : 9 : 6.

There is here therefore a difference in the amount of oxygen of the silica, precisely as is the case with respect to lime-harmotome and baryta-harmotome. The experiments instituted with the view of elucidating this point not having as yet led to any decisive result, the former of the above formulæ, which is the one which expresses the constitution of the generality of chabasites, is, for the present, assumed to be the correct one.

Naumann looks upon this species as a lime-chabasite, in which a portion of the lime is always replaced by soda and potash, an opinion which, it will be observed, is not borne out by Thomson's analyses of the Kilmalcolm variety cited above; he likewise is inclined to attribute the excess of silica shown in some analyses of this species to the presence of interposed quartz. The formula which he adopts (as does also G. Rose), which is the one followed here, requires 47·92 silica, 20·0 alumina, 11·08 lime, water 21·0.

LOCALITIES.—Chabasite is met with in fissures or cavities of basaltic rocks, or within geodes of quartz and agate disseminated in those rocks; in attached crystals and massive.

Scotland.—Sometimes in colourless, transparent crystals, an inch across in trap at Kilmalcolm, P, P *s*, P *s e*; recently very fine, at Grainger's quarry, half a mile north of Alton House, two miles and a half S.W. of Kilmalcolm, with forms P, P *t s*. Near Old Kilpatrick, and at Port Glasgow. At Glen Farg in Fifeshire; in the Island of Mull; in Eig, on the coast of Argyleshire; beautifully and variously crystallized, at Storr, Lyndale, Quirang, and Talisker in the Isle of Skye. At Talisker, lately, and with the form P, in very fair specimens of a pinkish colour (*arcadialite*).

The *glottalite* of Thomson is chabasite (see Phil. Mag. for Aug. 1855), occurring in small aggregated and irregular crystals, somewhat like figure 4, after the manner of phacolite.

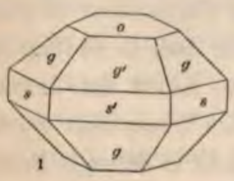
Ireland.—This mineral occurs at the Causeway along with stilbite, in fine white translucent crystals, and in amygdaloid at Ballintoy; the best specimens from Portrush are of considerable size and transparent. Near the Ball in Rathlin Island, with crystals of calc-spar. At Magee Island near Larne, of a light red colour; also in bluish-white transparent crystals in the cavities of a ferruginous amygdaloid at Salough Braes near Larne. In amygdaloid at Portstewart. In smaller crystals at Benbradagh, Craignashoke, Slieve Gallion Carne, &c.

Crystals presenting the form of figure 4, sometimes known as phacolite, but shown by Brooke (see Phil. Mag. vol. xi. for 1837) to be chabasite, occur at the Giant's Causeway, and also at the Castle Rocks, Magilligan, Derry; at the latter locality, crystals with the form of figure 3 also occur imbedded in cavities of amygdaloidal greenstone, the crystals well defined, large and translucent, to opaque, colour greyish-white or pinkish; sometimes, according to Portlock, associated with radiating groups of orange-coloured natrolite.

Note.—Dr. Heddle mentions the following Isle of Skye forms: viz. at Lyndale, P; P*a*; P*esa*, and P*ea*, in simple crystals: P*s*; P*es*; P*esa*; P*est*; P*esta*, and *esta* twinned: at Talasker, P; P*s*; P*e*; P*es*: at Storr, P; *ts*; and twins, P*s*, P*es*: at Quirang, P; P*sa*; P*esa*, twins. Figures 6, 7 and 8 represent Skye crystals.

84. GMELINITE.—Gmelinite, *Brooke* and *Miller*; Sarcolite, *Thomson*; Hydrolite, *Beudant*; Hydrolith, *Leman*; Gmelinit, *Haidinger, Hausmann, G. Rose.*

Rhombohedral. Cleavage very distinct parallel to planes of the hexagonal prism. Face *o* rough. Crystals in all probability twins. Twin face *o*. In crystals like figure 2, the twinned combination is very marked. Crystals of the form of figure 1, if carefully examined, not unfrequently afford similar indications. This is the most common form in which this species occurs, and according to Breithaupt, is a twin form



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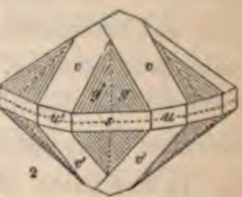

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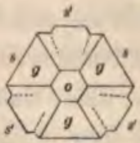

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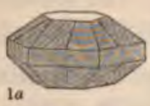
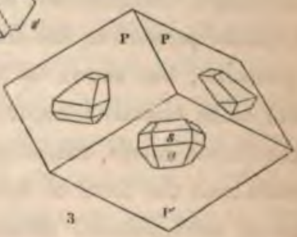


1a



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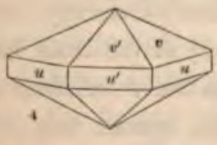


4

g g'	142° 25' adjacent	*g v*	161° 13'	*o v*	143° 56'	*s s'*	120° 00'
g' g'	80 30 over *s*	*o g*	139 56	*v u*	126 04	*u s*	150 00
g s	130 04	*o s*	90 00				

of the rhombohedron $\frac{2}{3}$ R. The planes of the pyramids are striated parallel to their polar edges, those of the prism *s* striated horizontally, as in figure 1*a*. Lustre vitreous. Translucent in a low degree. White, yellowish and reddish-white, to flesh-red, also grey. Brittle, especially the red varieties. H. 4·5; Gr. 2 to 2·1.

Combinations observed in Irish specimens: *s g o*; *s g v*; *s g u v*; *s g u v o*; *v u*; *v u g*.

When held in the flame of a candle flies off in small scales. In the matrass yields water and falls to powder. Fuses before the blowpipe into an opaque glass. Is decomposed by hydrochloric acid, forming a complete jelly of silica.

Analyses: *a*, from Glenarm, Antrim, by Connel; *b*, *c*, from the same locality, by Rammelsberg:—

	a.	*b.*	*c.*
Silica	48·56	46·398	46·564
Alumina	18·05	21·085	20·186
Peroxide of iron . .	0·11	...	...
Lime	5·13	3·672	3·895
Soda	3·85	7·295	7·094
Potash	0·39	1·604	1·873
Water	21·66	20·412	20·412
	98·75	100·466	100·024

$(\dot{N}a,\dot{C}a,\dot{K})^3\dddot{Si}^2+3\dddot{\bar{Al}}\dddot{Si}^2+18\dot{\bar{H}}$. In Gmelinite and chabasite the oxygen of the alkaline bases $(\dot{N}a,\dot{C}a,\dot{K})$ is to that of the alumina, silica, and water as 1 : 3 : 8 : 6, the difference in their composition consisting in the relative quantities of those bases. In its chemical constitution, therefore, this species may be looked upon as a soda-chabasite, while chabasite may be held to be a lime-chabasite: $(\dot{N}a^2,\dot{C}a)^3\dddot{Si}^2+3\dddot{\bar{Al}}\dddot{Si}^2+18\dot{\bar{H}}$ gives silica, 47·57; alumina, 19·85; lime, 3·67; soda, 8·05; water, 20·86.

The following remarks upon Gmelinite are translated from Professor G. Rose's recent work, 'Das Krystallo-chemische Mineralsystem.' "The crystals of Gmelinite are combinations of a hexagonal dodecahedron with the first hexagonal prism and the terminal plane, occasionally also with the first, more obtuse dodecahedron, whose planes form replacements of the terminal edges of the primary. The angles on the lateral edges of the primary are stated by Brewster, probably by an oversight, to be 96° 24′; indeed, Haidinger, in the English translation of the 'Mineralogy' of Mohs, states their value to be 83° 36′, which is the complement of the angle above mentioned. Tamnau, in his paper upon chabasite, in accordance with my measurements, estimates them at 80° 54′. Dufrénoy reduces them to 80° 06′, an amount which Breithaupt further lessens to 79° 44′. The angle on the lateral edges of the first more obtuse hexagonal dodecahedron is 72° 34′, as determined by Tamnau. This angle is an approximation to that formed by the planes of the hexagonal dodecahedron met with in chabasite, and Tamnau assumes the two angles to be equal, and that Gmelinite is but a variety of chabasite. In this case the usual hexagonal dodecahedron of Gmelinite would in chabasite be a hexagonal dodecahedron of the first order, and the prism which is met with in Gmelinite would be the first hexagonal prism of chabasite. But neither the latter, nor a hexagonal dodecahedron of the first order, occur in chabasite, nor, indeed, does the terminal plane, which latter is frequently met with in Gmelinite. Moreover, the cleavage in Gmelinite is altogether different from that in chabasite, inasmuch as it is not, as is asserted in mineralogical books, parallel to a rhombohedron, as is the case with chabasite, but, as I have ascertained beyond all question, parallel to the planes of the hexagonal prism; it is, moreover, very distinct. Now, since the agreement of the angles alluded to is only approximate, the union of Gmelinite and chabasite does not appear to me to be borne out. It must further be observed, that Gmelinite, however, does occasionally affect a rhombohedral character. In the Royal Collection at Berlin there are two specimens from Antrim, in which the alternate faces of the hexagonal dodecahedron are considerably more developed than the others. These occur also in twins, which, to the best of my knowledge, have not been hitherto described. Although, from what has been said, the union of Gmelinite and chabasite does not seem justified as far as form is concerned, yet, according to the analyses by Rammelsberg, in chemical composition they agree entirely. From those analyses the same formula is applicable to Gmelinite and chabasite, the former being distinguished from the latter merely by having a portion of the lime replaced by a corresponding quantity of soda. The forms being different, it must be assumed that Gmelinite and chabasite are two heteromorphous bodies standing relatively to each other as rutile and anatase do, for both belong to the same system; they stand also in a similar relation with regard to cleavage that Gmelinite and chabasite do, for in rutile the cleavage is parallel to a square prism, and in anatase parallel to an octahedron with a square base, while in Gmelinite and chabasite it is parallel to a hexagonal prism and a rhombohedron."

Mr. Brooke describes in the 'Philosophical Magazine' for 1837, vol. x. p. 278, "Crystals of chabasite penetrated according to a regular law by small crystals of Gmelinite (see figure 3); a similar disposition has been noticed also in other heteromorphous substances, as, for instance, in the case of pyrites and marcasite." Gmelinite is found coating the cavities of amygdaloidal rocks. It has been observed hitherto in the United Kingdom only in the trap districts of the N.E. of Ireland and in Skye.

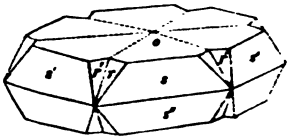
LOCALITIES.—*Scotland.* At Talisker in Skye, according to Heddle, in large colourless crystals with form of figure 5, in trap.

Ireland.—Antrim; in large and nearly opaque crystals of a greenish-white colour at Portrush, but not common there. The compound form *s g v* is the one most usually met with. At

Little Deer Park, Glenarm, in greenstone, in very distinct and perfect crystals, of the form of figure 1, white and translucent. At Magee Island, where it is very common in the cavities of the trap, in the forms both of figures 1, 2 and 4. The crystals are commonly small, but measure occasionally half an inch across. In colour they range from straw-yellow to deep flesh-red, and vary from opaque to transparent. They are often associated with small pinkish crystals of Phillipsite and with mesotype and analcime. At Larne Glen and Black Head near Larne, in large crystals of a pale flesh-colour and nearly transparent. Gmelinite sometimes occurs imbedded in chabasite, as is shown in figure 3, representing the primary form of an Antrim chabasite, each plane of which, P, is penetrated by a small crystal of Gmelinite, the axis of the rhombohedron of chabasite being perpendicular to the terminal plane *o* of Gmelinite. This disposition of the crystals was observed by Mr. Brooke to be constant in every instance in which he noticed its occurrence. Sometimes the face of the chabasite was covered with a single crystal of Gmelinite, sometimes studded with many small ones. For further details reference may be made to the volume of the 'Philosophical Magazine' alluded to above. Londonderry; at Down Hill, in small crystals, rare. At Craignahish, in amygdaloid, in small white crystals of the form of figure 1, associated with mesole. Similarly at Benbradagh, at Benyevenagh and Magilligan.

85. LEVYNE.—Levyne, *Brewster*, *Brooke* and *Miller*; Levyn, *Haidinger*, *Naumann*; Levyne and Mesolin, *Berzelius*.

Rhombohedral. The faces *r*, *s* striated parallel to their intersections with each other, *o* uneven and usually rounded. Twins. Twin face *o*. Cleavage *s*, indistinct. Fracture uneven, imperfect conchoidal. Semitransparent. Lustre vitreous. Colour white, yellowish, reddish. Brittle. H. 4; Gr. 2·1 to 2·2.



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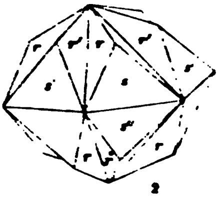


2

r o	136°	01′
s o	117	23
s s	125	12

Chemical characters the same as those of chabasite.

Analyses: *a*, mesolin, *b*, Levyne, from Faröe, both by Berzelius; *c*, from Skye, by Connel; *d*, *e*, *f*, from Iceland, by Damour; *g*, by Thomson.

	a.	*b.*		*c.*	*d.*	*e.*	*f.*	*g.*
Silica . .	47·50	48·00		46·30	45·76	44·48	45·04	44·75
Alumina .	21·40	20·00		22·47	23·56	23·77	21·04	20·33
Lime . .	7·90	8·35		9·72	10·57	10·71	9·72	8·84
Magnesia	...	0·40	$\dot{F}e$ & $\dot{M}n$	0·96	...	...	...	0·77
Soda . .	4·80	2·86		1·55	1·36	1·38	1·42	3·33
Potash .	...	0·41		1·26	1·64	1·61	1·63	...
Water .	18·19	19·30		19·51	17·33	17·41	17·49	20·00
	99·79	99·32		101·77	100·22	99·36	99·34	98·02

$\dot{C}a\ddot{S}i+\ddot{A}l\ddot{S}i+4\dot{\text{Ħ}}$; with silica, 44·36; alumina, 24·68; lime, 13·68; water, 17·28. The union of Levyne and chabasite as one species is a point which has been so much discussed, that the following remarks thereon, translated from Professor G. Rose's 'Krystallo-chemische Mineralsystem,' may not be deemed out of place here, more especially as the view which that learned mineralogist adopts is by no means in harmony with the opinion upon this matter expressed by Brooke and Miller at page 452 of their 'Mineralogy,' under the head of Gmelinite. "Levyne was first established as a distinct species by Brewster, and its crystals were measured and drawn by Haidinger. It was subsequently analysed by Berzelius and Connel, the former employing for this purpose the variety from the Faröe Islands, specimens of which Brewster transmitted to him, and the latter employing another variety from Skye. Berzelius found the composition to agree with that of chabasite, whence he inferred that the two minerals were one and the same species. The analysis published subsequently by Connel was to some extent different, and as its result was somewhat improbable in itself, Berzelius thought himself justified in attaching no value to it.

"Adopting the analysis by Berzelius, Tamnau endeavoured also to reduce the form of Levyne to that of chabasite; this, however, could only be brought about by a very forced manner of proceeding. Crystals of Levyne have nothing in common with those of chabasite, except that they both belong to the rhombohedral system, and that both present twin crystals, combined according to the same law, which, however, is the commonest which obtains in that system. Not one of the three rhombohedrons observed in Levyne, nor indeed even the terminal plane, occurs in chabasite. It would, it is true, be possible to refer these rhombohedrons to those which are met with in chabasite, if one admitted unimportant variations in the angles of Levyne, which would perhaps be allowable, inasmuch as crystals of Levyne are not met with so smooth and shining as to admit of perfect measurements being made; but the ratios of these rhombohedrons are then not the simple ones which commonly obtain, so that a union of these two minerals does not seem warranted. Granting the admissibility of such a course, all rhombohedral crystals might be referred to each other. Moreover, I have in vain endeavoured to establish the existence in Levyne of such a cleavage as occurs in chabasite." Breithaupt, who adopts the views of Tamnau, does so for no other reason than to render the union possible.

There is, however, also another circumstance which renders it impossible that Levyne and chabasite are but varieties of one species, namely, the manner in which they occur together. Levyne and chabasite are met with in small cavities of one and the same basaltic rock, but each in a separate cavity, never both together in the same cavity. Brewster at the outset alluded to this; Tamnau mentions it too; it is further borne out by the specimens in the Royal Collection at Berlin; and Dr. Heddle, who has had much personal experience among the trap rocks of our western isles and the Faröes, states the same, mentioning in addition, that Levyne is the *sole* tenant of its druses, even though these druses be within a quarter of an inch of others containing chabasite *associated with half a dozen other zeolites*: in only a solitary instance in Skye did he see minute crystals of analcime superimposed on Levyne. This is not, however, at all the way in which varieties of one species occur.

If, therefore, the analysis by Berzelius is correct, chabasite and Levyne would have to be regarded as two heteromorphous substances. But it is also possible that he may have examined a mixture of chabasite and Levyne; and this might easily be the case if, owing to the minuteness of the cavities in which chabasite and Levyne crystals are met with in the Faröe Islands, he employed for his analysis crystals from different cavities. The more recent analysis by Damour renders this supposition probable, inasmuch as its result differs from that obtained by Berzelius. In Damour's formula (which is the one adopted above) the amounts of oxygen in $\dot{R}, \dddot{\bar{Al}}, \dddot{Si}$ and $\dot{\bar{H}}$ are in the ratio 1 : 3 : 6 : 4, agreeing therefore with the formula of natrolite, but with a different amount of water.

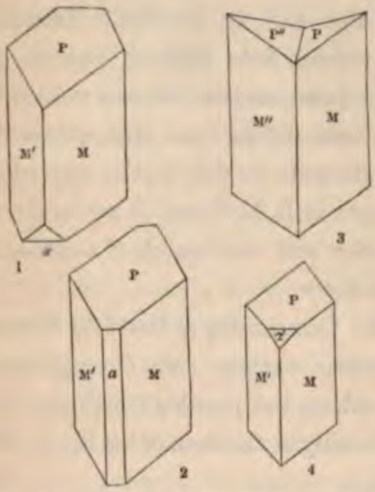
Localities.—*Scotland*. Occasionally at Hartfield Moss near Glasgow, of a flesh-red colour, opaque. Mr. Greg possesses a solitary crystal of a flesh colour, but possibly Gmelinite, nearly an inch across, from this locality in the form of fig. 2. In Skye, at Storr, fig. 1.

Ireland.—Antrim; at Little Deer Park, Glenarm, in small distinct translucent crystals, of the form of fig. 1, in trap, with mesotype. At Island Magee, of a yellowish-white or pale flesh-red. Londonderry; at Cluntygeeragh near Dungiven. At

Cabragh in Termoneeny parish. At Magilligan, in yellowish-white opaque crystals in amygdaloidal greenstone. At Banevenagh, in greenish-white translucent crystals.

86. LAUMONITE.—Laumonite, *Brooke* and *Miller*, *Dana*, *Phillips*, *Hauy*; Laumontit, *Hausmann*, *Naumann*; Laumonit, *Haidinger*, *v. Kobell.*

Oblique. Primary form an oblique rhombic prism. Twin-face *b*. Cleavage *b* perfect, *i. e.* parallel to plane replacing the obtuse edge between M and M; imperfect parallel to *a* and M. Fracture uneven. Lustre vitreous, sometimes inclining to pearly; decidedly pearly on the distinct cleavage plane. Transparent to translucent on the edges, and opaque. Yellowish and greyish-white, sometimes pale flesh-red. Streak white. Very brittle. H. 3 to 3·5; Gr. 2·2 to 2·3.



M M'	86° 16'
M P	113 30
M x	104 10
P a	125 41
P x	57 01
a x	111 20
P z	149 15

Combinations; P M; P M *a*; P M *x*; P M *z*. The form *z* not before described.

In the matrass yields water. Intumesces before the blowpipe and melts into a white enamel, which at an increased temperature becomes transparent. Is decomposed by hydrochloric acid, forming a jelly of silica. Effloresces gradually on exposure to the air, and becomes opaque and crumbling, in consequence, as Malaguti and Durocher maintain, of losing a portion of the water contained in it. The original freshness of the specimens may be restored by immersing them in water. The best way, however, to preserve the beauty of this mineral is, where it can be conveniently done, to keep the specimens in water, or, where that cannot be well managed, to let them stand for some days in thin gum-water in which some sugar is dissolved. Thus preserved they will maintain themselves for some years without crumbling to pieces.

Analyses: *a*, from Huelgoet, in Brittany, by Malaguti and Durocher; *b*, from Skye, by Babo; *c*, from Storr, in Skye, by Scott; *d*, from Skye, by Delffs; *e*, by Connel, from Snizort:—

	a.	*b.*	*c.*	*d.*	*e.*
Silica . .	52·47	52·30	53·04	51·17	52·04
Alumina .	22·56	22·30	22·94	21·23	21·14
Lime . . .	9·41	12·00	9·67	12·43	10·62
Water . .	15·56	14·20	14·64	15·17	14·92
	100·00	100·80	100·29	100·00	98·72

$(\dot{C}a^3\dddot{S}i^2+4\dddot{\bar{A}}l\dddot{S}i^2)+15\dot{\bar{H}}$; with silica, 52·13; alumina, 23·15; lime, 9·48; water, 15·24. G. Rose and Naumann give $\dot{C}a^3\dddot{S}i^2+3\dddot{\bar{A}}l\dddot{S}i^2+12\dot{\bar{H}}$ as more closely representing the constitution of this species. This second formula requires—silica, 51·66; alumina, 21·50; lime, 11·74; water, 15·10.

In attached crystals, granular and massive, as a constituent of some greenstones, in veins in porphyry and trap, and in cavities in amygdaloidal rocks.

Localities.—*Scotland.* Argyleshire; Isle of Mull, massive and crystallized, at Loch Screden; the form figure 4 occurs there, and was noticed by Dr. Heddle. Dumbarton; well crystallized at Long Craig, Dumbarton Muir; also near Old

Kilpatrick. Inverness; at several points in the Isle of Skye, as at Snizort, in veins 3 inches thick, with stilbite; in acicular highly transparent crystals, on stilbite, near Talisker; between Loch Eynort and Loch Brittle; also at Storr. Renfrewshire; at Hartfield Moss, in white and translucent crystals of the form of figure 1. The Laumonite here forms a vein in the trap rock; Prehnite and analcime are here abundant too. At the same locality twin-crystals of the form of figure 3 have been met with quite recently. It is not known to have been observed before, and as yet appears to be a very scarce form. Singularly combined with barytes at Cloak near Lochwinnoch; with finely crystallized calcite at Kilmalcolm. The simple form M P occurs at this locality in crystals nearly an inch long; they are opaque, pale brick-red, and partially decomposed now and then. In the neighbourhood of Paisley. Stirlingshire; at Carbeth, finely crystallized. With mesotype at the Campsie Hills. Fife; of a deep red colour at Glen Farg.

Ireland.—Antrim; at Larne. At Portrush, rarely. At Ballintoy, with stilbite. Down; according to Sir C. Giesecke, Laumonite occurs in the granite of the Mourne Mountains.

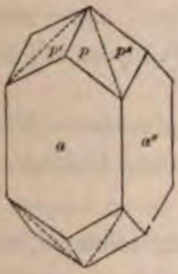
The new mineral from Skye, analysed by Mallet (Silliman's Journal, Sept. 1856, p. 179), is weathered Laumonite, according to Heddle. See Phil. Mag., Jan. 1857. It is described occurring as a compact mass of minute crystals, like white loaf-sugar when broken. Sp. Gr. 2·25. It contained—

Silica	53·95
Alumina	20·13
Lime	12·86
Magnesia	0·87
Water	12·42
	100·23

This species was named by Hauy after the French mineralogist, Gillet de Laumont, and ought therefore, in strictness, to be termed Laumontite.

87. **PHILLIPSITE,** *Brooke* and *Miller, Dana, Levy*; Christianite, *Descloizeaux*; Lime-Harmotome, *Connel.* Potash-Harmotome. Phillipsit, *Haidinger, Hausmann, v. Kobell, Naumann.*

Prismatic. Primary form a right rectangular prism. The angles of the pyramid 123° 30′ and 117° 30′. Always twinned or in compound crystals, but the twins are frequently arranged so symmetrically that they assume the appearance of simple crystals. Twin-face M. Twins intersect each other with coincidence of the main axis. Sometimes so grouped together by the intersection of such twins that the main axes are at right angles to each other. Cleavage parallel to *a* diagonal. Fracture conchoidal, uneven. Lustre vitreous. White, inclining to grey and pinkish. Transparent to translucent on the edges. Brittle. H. 4·5; Gr. 2·15 to 2·21. The lower specific gravity will readily distinguish this species from the ordinary or baryta-harmotome. The faces $p\,p'$ are sometimes very nearly in one plane, so that the re-entering angle becomes barely perceptible.



$a\,a''$	90° 00′
$p\,p'$	121 06

Before the blowpipe intumesces somewhat while melting. Decomposed in hydrochloric acid with the formation of a *jelly* of silica. In baryta-harmotome the silica is obtained in a granular state.

Analyses: *a*, from the Stempel, near Marburg, by Genth; *b*, from Giant's Causeway, by Connel:—

	a.	*b.*
Silica	48·17	47·35
Alumina	21·11	21·80
Peroxide of iron	0·24	...
Lime	6·97	4·85
Potash	6·61	5·55
Soda	0·63	3·70
Water	16·62	16·96
	100·35	100·21

$(\dot{Ca}^2, \dot{K})\dddot{Si}^2 + 3\ddot{\bar{Al}}\dddot{Si}^2 + 15\dot{\bar{H}}$; silica, 48·53; alumina, 20·20; lime, 7·36; potash, 6·18; water, 17·73; $\dot{R}$ being made $\frac{2}{3}\dot{Ca} + \frac{1}{3}\dot{K}$.

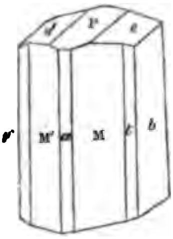
In attached crystals in cavities in amygdaloid and basalt.

Localities.—*Ireland.* Antrim; in white translucent crystals of the form of the figure, sometimes $\frac{3}{4}$ of an inch long, in highly cellular trap, at Pleaskin or Plaiskins, a headland close to the Causeway. In minute crystals of a flesh-colour, with Gmelinite, lining cavities in amygdaloid, at Magee Island. Londonderry. At Portstewart. With chabasite, at Magilligan, or Tamlaghtard.

The name Phillipsite was given to this mineral by Levy, in compliment to the late W. Phillips. Some recent French mineralogists have given the name Phillipsite to purple copper.

88. BREWSTERITE.—Brewsterite, *Brooke* and *Miller*, *Phillips*, *Beudant*; Brewsterit, *Hausmann*, *Haidinger*, *v. Kobell*, *Naumann.*

Oblique. The crystals are short, columnar, composed of numerous vertical prisms, terminated by an extremely obtuse, almost horizontal clinodome (173° 10′), whereby the species is easily recognized. Cleavage highly perfect parallel to *b*, traces parallel to *a*. Fracture uneven. Yellowish-white and greyish-white. Lustre pearly on *b*, on other planes vitreous, P being very brilliant. Brittle. Transparent to translucent. H. 5 to 5·5; Gr. 2·1 to 2·2.



M M'	136° 00'	
P M	92 43	
M *b*	112 00	
P *a*	93 40	
P *b*	90 00	
a b	90 00	
e e	173 10	(173·30) G.
t b	128 56	

Combinations: M P *a b e*; M *a b e t*; M P *a b e t*. Occurs also massive.

In the matrass yields water and becomes opaque. Intumesces and froths up before the blowpipe. Soluble in hydrochloric acid, leaving a residue of silica.

Analyses, from Strontian: *a*, by Connel; *b*, by Thomson:—

	a.	*b.*	*c.*
Silica	53·666	53·045	54·87
Alumina	17·492	16·540	15·27
Peroxide of iron .	0·292	. . .	. . .
Strontia	8·325	9·005	8·79
Baryta	6·749	6·050	6·49
Lime	1·346	0·800	1·21
Water	12·584	14·735	13·37
	100·454	100·175	100·00

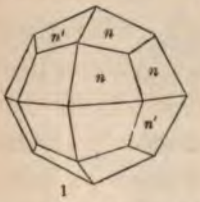
$(\dot{R}\dddot{Si}+\dddot{Al}\dddot{Si}^3)+5\dot{H}$, $\dot{R}$ being $\dot{Sr}, \dot{Ba}, \dot{Ca}$; and since the proportion of these bases is about 4 : 2 : 1, the calculated composition of this species would be as shown above in column *c.* The formula is identical with those for Heulandite and epistilbite, with the exception of the 1-atomic bases which in Brewsterite are strontia and baryta, while in Heulandite and epistilbite they consist of lime and a portion of soda. But as these bases can replace each other, these three species are heteromorphous, the substance expressed by the above formula thus affording an instance of trimorphism.

Localities.—*Scotland.* Argyleshire; at Strontian, in small attached translucent crystals, both colourless and of a brownish tinge. Sometimes in fascicular groups with curved terminations, associated with calcite, galena and gneiss.

Ireland.—Antrim; coating cavities in amygdaloidal rocks at the Giant's Causeway.

89. ANALCIME.—Analcime, *Brooke* and *Miller*, *Phillips*, *Hauy*; Analcim, *Hausmann*, *v. Kobell*, *Naumann*; Analzim, *Haidinger*. Cubizite. Cluthalite, *Thomson*.

Cubic. Cleavage cubic, very imperfect. Fracture uneven, imperfect conchoidal. Lustre shining, sometimes pearly. Colourless, white, greyish-white to grey, reddish-white to flesh-red. Translucent, translucent on the edges to opaque. Brittle. Streak white. H. 5·5; Gr. 2·1 to 2·24.



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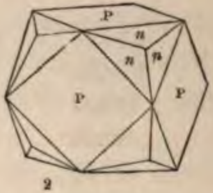


2

P P	90°	00′
P n	144	44
n n	146	27
n n'	131	49

Generally occurs in icositetrahedrons, as in figure 1; also like figure 2. In the Western Highlands, crystals having the form P are said to have been found by Mr. Clacher and by Lord Greenock.

In the matrass yields water, becoming white and dull. Before the blowpipe fuses quietly to a clear glass. Completely decomposed by hydrochloric acid, forming a jelly of silica.

Analyses: *a*, from Old Kilpatrick, by Connel; *b*, from the Giant's Causeway, by Thomson:—

	a.	*b.*
Silica	55·07	55·60
Alumina . . .	22·23	23·00
Soda	13·71	14·65
Water	8·22	7·90
	99·23	101·15

$\dot{N}a^3\dddot{Si}^2 + 3\,\dddot{\bar{Al}}\dddot{Si}^2 + 6\dot{\bar{H}}$; which requires silica, 55·03; alumina, 22·96; soda, 13·97; water, 8·04.

It is now very doubtful whether this substance is dimorphous, as the eudnophite of Weibe, at first considered to be prismatic in form, may (when more perfect crystals have been discovered) prove to be cubic.

Analcime usually occurs crystallized in the cavities of amygdaloidal rocks; occasionally in primitive and secondary rocks; it is common in the trap rocks of Ireland and Scotland.

Scotland.—Aberdeenshire; in the parish of Auchindoir. Dumbartonshire; at Bowling, in pseudomorphs after Laumonite; capped by Prehnite near Old Kilpatrick, and in large crystals; at Long Craig, and at the quarry half a mile above Old Kilpatrick, in fine crystals, with the forms *n*, P *n*. Edinburghshire; some years since, white opaque crystals, 6 inches across, were obtained at Salisbury Craig, but it usually occurs there in small transparent crystals; also at the Calton Hill, Edinburgh, and at Ratho quarry, in greenstone, sometimes in crystals 5 inches in diameter, and not unfrequently changed into pectolite and steatite. Fifeshire; with the form of figure 2 at Elie, also in small brilliant crystals in tufa at the Spindle Rock, near St. Andrews. Kincardineshire; in the parish of Kineff, *n* and P *n*. Perthshire; at Glen Farg, in fine flesh-coloured opaque crystals, presenting the forms *n*, P *n*. Renfrewshire; at Bishoptown and at Erskine; in small transparent crystals at Kilmalcolm, with stilbite; changed into *white* Prehnite, and forming an interesting pseudomorph (figure 2), at Hartfield. Stirlingshire; in large opaque white crystals, sometimes flesh-coloured, 2 or 3 inches in diameter, at the Campsie Hills, and accompanied with calcite, Prehnite, and mesotype. Analcime occurs in the trap rocks of Canna, Eig, Mull, and Staffa. At Waas in Hoy, Orkney, in amygdaloid; sometimes, according to Heddle, in translucent crystals (figure 2) 3 inches across.

Skye; at Talisker, of a bluish colour, in fine translucent crystals, with the form *n*; at Storr and at Quirang.

Ireland.—Antrim. It is a common mineral in the cavities of the trap and basaltic rocks, as at the Giant's Causeway, in small transparent crystals; at Dunluce Castle; near Port Stewart, as at O'Hara's Rocks, where it is plentiful, lining fissures and forming nodules in amygdaloid; it is sometimes studded with pyramidal crystals of yellow calcite; at Glenarm; at Doon Point; in Rathlin Isle, in fine white translucent crystals, with mesotype. Donegal; in large opaque crystals, with garnet and idocrase, at the junction of the quartz and trap-rocks, in a vein of Dolomite, near Gweedore. Derry; in large yellowish crystals at Craignashoke, parish of Ballinascreen, in amygdaloidal claystone; and similarly at Slieve Gallion; also at Donald's Hill; at Aghanhoo; at the Castle Rocks, Magilligan, and at Down Hill, in greenstone.

The name analcime is from ἄναλκις, *weak*, and alludes to its weak electric power when heated or rubbed.

Note.—The *Cluthalite* of Thomson would appear to be a ferruginous analcime. Vitreous. Colour flesh-red. H. 3·5; Gr. 2·166. Thomson obtained,—

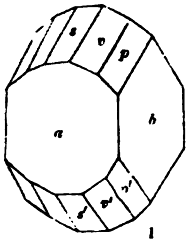
Silica	51·266
Alumina	23·560
Protoxide of iron . . .	7·306
Soda	5·130
Magnesia	1·233
Water	10·553
	99·048

Formula, $(\dot{N}a^{\frac{1}{2}}\dot{F}e^{\frac{1}{2}})\dddot{S}i^2+3\dddot{A}l\dddot{S}i^2+8\dot{H}$ (Heddle); with silica, 53·14; alumina, 22·17; protoxide of iron, 7·59; soda, 6·74; water, 10·36: or $(\dot{N}a^{\frac{1}{2}}\dot{F}e^{\frac{1}{2}})\dddot{S}i^2+3\dddot{A}l\dddot{S}i^2+9\dot{H}$ (Kobell); with silica, 52·49; alumina, 21·81; protoxide of iron, 7·67; soda, 6·65; water, 11·48; or analcime with half of the soda replaced by protoxide of iron, and with some more water.

The mineral *now* sold as Cluthalite, is either Weissigite (which see) or massive analcime; as Weissigite (or albite), it is frequently a pseudomorph after stilbite; as analcime, after Laumonite or calcite; when pseudomorphous (or altered?) the lustre is very dull*.

90. **HARMOTOME.**—Harmotome, *Brooke* and *Miller, Dana, Phillips, Hauy*; Harmotom, *Haidinger, Hausmann, v. Kobell, Naumann.*

Prismatic. Naumann observes that by some this species is held to belong to the pyramidal system, while the proportions observable in certain repetitions of twin formations, would seem rather to refer it to the cubic system, the axes whereof have assumed different values. Breithaupt considers this species to



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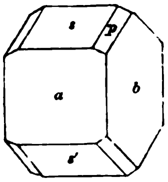

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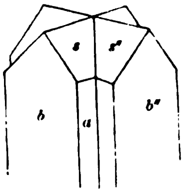

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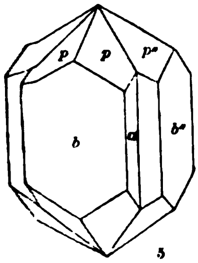

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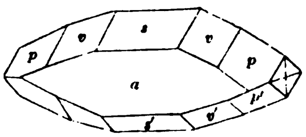

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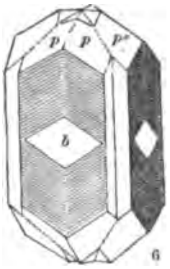

6

a b	90° 00'	*a s*	124° 47'	*b p*	120° 28'	*p p*	119° 04'	*p s*	149° 32'
a p	119 27	*a t*	144 15	*b v*	98 22	*p p'*	89 52	*s s'*	69 34

t replaces the edge *a s*.

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* Pseudomorphs of red analcime after Laumonite, the crystalline faces of which are rough and soft, are found near Kilpatrick;—these may be Thomson's Cluthalite.

belong to the anorthic system. The prismatic system is the one adopted here. Twin-face and cleavage parallel to tangent plane, replacing edge between *a* and *b*. Crystals columnar, almost always twinned, the main axes of the two individuals coinciding. Rarely twins are met with in which the twin-face is a plane of the pyramid, whereby the main axes of the two individuals are almost at right angles to each other. Fracture uneven. Transparent to translucent. Colourless, white or grey. Lustre vitreous to pearly. Streak white. Brittle. H. 4·5; Gr. 2·4 to 2·43.

British forms. *bs*; *bsp*; *abt*; *abp*; *abtp*; *abs*; *absp*; *abspr*; *abtv*; *abtsp*; *abtr*; *abtpv*; *absvp*; *abtsvp*; and twins of *abs*; *abp*; *absp*; *abtv*; *abtpv*; *abspr*.

In the matrass yields water. Before the blowpipe fuses without intumescence, not, however, very readily, to a transparent white glass. In powder is completely decomposed by hydrochloric acid, leaving silica in powder.

Analyses: *a*, from Strontian, Argyleshire; *b*, the small clear crystals termed Morvenite by Thomson, also from Argyll, both by Damour; *c*, from Strontian, by Köhler; *d*, from Andreasberg, by Rammelsberg; *e*, from Strontian, by Connel:—

	a.	*b.*	*c.*	*d.*	*e.*
Silica . . .	47·74	47·60	46·10	48·74	47·04
Alumina . .	15·68	16·39	16·41	17·65	15·24
Perox. of iron	0·51	0·65	...	...	...
Baryta . .	21·06	20·86	20·81	19·22	20·85
Soda . . .	0·80	0·74	(Lime) 0·63	...	0·84
Potash . .	0·78	0·81	0·90	...	0·88
Water . . .	13·19	14·16	15·11	14·66	14·92
	99·76	101·21	99·96	100·27	99·77

$(\dot{\mathrm{Ba}}\dddot{\mathrm{Si}}+\dddot{\bar{\mathrm{Al}}}\dddot{\mathrm{Si}}^2)+5\dot{\bar{\mathrm{H}}}$; silica, 44·52; alumina, 16·48; baryta, 24·54 (including potash, soda, and lime); water, 14·46: we should prefer $\dot{\mathrm{Ba}}^3\dddot{\mathrm{Si}}^4+3\dddot{\bar{\mathrm{Al}}}\dddot{\mathrm{Si}}^2+15\dot{\bar{\mathrm{H}}}$; with silica, 47·13; alumina, 15·70; baryta, 23·39; water, 13·78.

In attached crystals in metallic veins in slate and transition rocks, in cavities in amygdaloidal rocks and basalt.

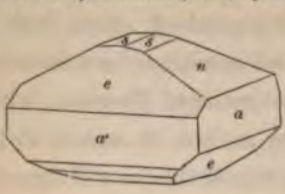
LOCALITIES.—*Scotland.* Argyleshire; abundantly at Strontian in fine white and translucent crystals $\frac{3}{4}$ of an inch in length, with calcite and barytes; good specimens have been met with lately at this locality. The *Morvenite* of Thomson, which is merely harmotome, as shown by analysis *b*, occurs at the same place in small transparent crystals of the form of figure 3. Harmotome at this locality occurs in mineral veins in granite near its junction with the gneiss. The forms met with here are shown in figures 1, 2, 3. Also *a b s*, *a b s p v*, twin forms; Morvenite, *a s p*, *a s p v*. Dumbartonshire; near Old Kilpatrick, usually in small colourless crystals, of the form of figures 4 and 6, associated with cluthalite and Edingtonite; lately, however, some very fine specimens have been met with little inferior, indeed, to those which are found at Strontian; also *a b p s*; *a b t v*; *a b p*, all twin forms. Stirlingshire; at the Campsie Hills, well crystallized, like figure 1. Edinburghshire; Costorphine Hill, with the form *a b p s*.

Ireland.—Co. Antrim; in basalt with the form of figure 1, at the Giant's Causeway.

The name harmotome is derived from *ἁρμόζω, ἁρμόττω, to join,* and *τέμνω, to cut, to cleave,* with reference to the division of which the crystals are susceptible at the junction of the planes of the pyramid.

91. EDINGTONITE.—Edingtonit, *Haidinger, Hausmann, Naumann.*

Pyramidal. Primary form an octahedron with a square base. The forms to which *e, n, o* belong are hemihedral, with inclined faces. Cleavage *a* very distinct. Fracture imperfect conchoidal, uneven. Lustre vitreous; *n, o* rather dull, so much so as to suffice for the recognition of the species, frequently somewhat curved. Semi-transparent, translucent. Greyish-white, sometimes tinged brown. Brittle. H. 4 to 4·5; Gr. 2·694, Heddle; 2·71, Turner.



a a'	90° 00'	
a' e	133 39	
a n	115 26	
a s	108 00	
e e	92 41	over summit
n n	129 08	do. do.

Combinations: *a e n*; *a e n s.*

Yields water in the matrass, and becomes white and opaque. Before the blowpipe fuses with some difficulty into a colourless glass. In hydrochloric acid forms a siliceous jelly.

Analysis by Dr. Heddle:—

Silica	36·98
Alumina	22·63
Baryta	26·54
Lime	0·22
Strontia	0·08
Soda	trace
Water	12·46
	98·91

$(3\dot{B}a\dddot{S}i+4\ddot{\bar{A}}l\dddot{S}i)+12\dot{\bar{H}}$. The formula requires silica, 37·263; alumina, 23·751; baryta, 26·524; water, 12·462=100.

Edingtonite was first noticed by Haidinger on a specimen of Thomsonite in small distinct crystals. It was found by Mr. Edington in 1823 on Lord Blantyre's estate, one mile and a half from Old or West Kilpatrick, in Dumbartonshire. It has been found lately again, both crystallized, and, in one specimen, massive. The specimens recently met with are associated with the mineral substance termed by Thomson *Cluthalite*, and also with harmotome. Dr. Heddle, who has so kindly furnished the Authors with the above analysis, and who has had numerous opportunities of studying specimens of this species, informs them that he has not in a single instance seen this mineral associated with Thomsonite, but that its frequent occurrence with harmotome led him to conjecture it might contain baryta, a supposition which the analysis fully bore out. It will be observed, however, that Edingtonite is simpler in its constitution than harmotome, as it consists of neutral silicates. Edingtonite is even now a very rare mineral, but its scarcity is probably to be ascribed rather to the insignificance of its appearance than to its intrinsic rarity. Were it, in truth, as scarce as it was supposed to be, it is not probable that one of the authors, as is the case, should have discovered seven or eight good specimens in the hands of various dealers. No crystals are as yet known above ⅜ths of an inch across. The faces *s* are rarely visible, and slightly curved.

For particulars of Dr. Heddle's analysis of Edingtonite, see the Philosophical Magazine for March, 1855. It occurred most frequently at a quarry half a mile N.E. of Old Kilpatrick; with Prehnite at Bell's quarry near Bowling quarry; and also at a quarry five miles north of Old Kilpatrick, where two specimens in Prehnite were found. Kilpatrick quarry has very lately been reopened for the express purpose of obtaining this mineral, but not a single specimen was found.

92. WEISSIGITE.—Weissigite, *Jenzsch.* Felspar (in part). Albite (in part). Cluthalite (in part). ?

Monoclinic. Crystals very small and indistinct. Cleavage unequal in two directions, parallel to the vertical axis, and meeting at 118°; also in the direction of a hemidome, inclined 106° to the brachydiagonal. Sometimes in twins. Also massive and in veins, and frequently pseudomorphous. Lustre vitreous. Colour white to pale rose-red. Streak white. H. 6·5; Gr. 2·538 to 2·548.

With blowpipe fuses easily on the edges to a white, somewhat blebby enamel, and tinges the outer flame weak red and yellow at the point. The red colour more distinct on platinum, but less so than with petalite. With borax a colourless glass; with salt of phosphorus, a silica skeleton. Insoluble in acids.

Analyses: *a*, from Weissig, in Saxony, by Jenzsch; *b*, from near Old Kilpatrick, in pseudomorphs, by Heddle; *a* being felspar, and *b* albite:—

	a.	*b*.
Silica	64·5	68·57
Alumina	17·0	20·42
Magnesia	0·9	...
Potash	14·6	1·06
Soda and lithia	2·2	9·73
Water	0·8	0·54
	100·0	100·32

Analysis *a* can lead only to the formula $\dot{K}\ddot{Si}+\dddot{Al}\dddot{Si}^3$; with silica, 65·21; alumina, 18·13; potash, 16·66: or *felspar*; while *b* leads only to $\dot{Na}\ddot{Si}+\dddot{Al}\dddot{Si}^3$; with silica, 69·09; alumina, 19·22; soda, 11·69: or *albite.*

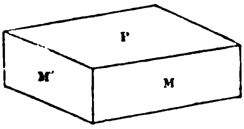
Occurs in the trap-rocks of Saxony and Scotland, associated with zeolitic minerals. In pseudomorphous crystals of a dull brick-red colour, after Laumonite and analcime, at the Calton Hill, Edinburgh, in trap-rock; massive and pseudomorphous near Old Kilpatrick, Dumbartonshire.

LOCALITIES.—*Scotland.* Occurs at Old Kilpatrick massive in analcime; botryoidal and mammillated in druses along with analcime, Thomsonite, harmotome and Edingtonite; the surface of these mammillations is rough, consisting of minute crystalline scales; rarely *per se* of a fine red colour, superimposed on quartz. At the Long Craig, near Dumbarton, in large pseudomorphs after stilbite, with quartz, analcime and Prehnite. At Hartfield Moss in Renfrewshire. Campsie Hills, Stirlingshire.

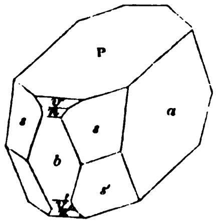
Note.—The authors have for the present thought it desirable to retain the name of Weissigite, so as more easily to distinguish a mineral which, occurring under precisely similar conditions, and presenting similar appearances, seems in Scotland to be *albite*, and at the Saxon locality noticed by Jenzsch to be *felspar*. The Scotch variety (albite), which generally passes for *Cluthalite* (now shown to be only analcime), can hardly be distinguished from the Saxon variety (felspar).

93. PREHNITE, *Hauy, Phillips*.

Prismatic. Primitive form a right rhombic prism of 99° 56′. Cleavage pretty perfect parallel to P; very imperfect parallel to M. P M *a* more or less striated. Fracture uneven. Translucent. Colour various shades of apple-green, sometimes approaching white or yellow. Lustre vitreous; P pearly. Pyroelectric. H. 6·0 to 7·0; Gr. 2·97.



1



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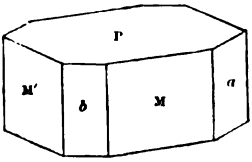


2

PM 90° 00′	M*b* 139° 58′	P*v* 153° 20′	P*s* 100° 43′	*b s* 138 35′
MM′ 99 56	M*a* 130 02	P*n* 134 53	M*s* 169 17	*r a* 123 57

Forms: P M; P M *a*; P M *a b*; P *a b v n s*; P M *a b v n s*.

In the matrass yields water without becoming opaque. Fuses before the blowpipe with effervescence into a blebby glass. After ignition is readily decomposed in muriatic acid, leaving a jelly of silica. With borax forms a transparent bead.

Analyses: *a*, from Dumbarton, by Walmstedt; *b* (*green*); *c* (*white*), from near Glasgow, by Thomson; *d* (*white*), from the Castle Rock, Edinburgh, by Lehunt:—

	a.	*b.*	*c.*	*d.*	
Silica	44·10	43·60	42·22	43·05	
Alumina	24·26	23·00	23·68	23·84	
Peroxide of iron .	. . .	2·00	. . .	. . .	
Lime	26·43	22·33	23·52	26·16	
Protoxides of iron, manganese, &c.	0·74	. . .	3·06	2·09	(with $\dot{K}$ and $\dot{N}a$)
Water	4·18	6·40	5·58	4·60	
	99·71	97·33	98·06	99·74	

Formula, $\dot{C}a^2\dddot{S}i+\dddot{\bar{A}}l\dddot{S}i+\dot{\bar{H}}$; with silica, 44·05; alumina, 24·50; lime, 27·16; water, 4·29.

Usually occurs in botryoidal and mammillated groups, or with crystals much attached to each other by the face P, forming fan-shaped groups; also massive, pseudomorphous. It is very plentiful at some of the Scotch localities; occurs usually in the cavities of trap and greenstone, sometimes with quartz and axinite.

Localities.—*England.* Cornwall; in small groups of a pale green colour, between the Botallack mine and Huel Cock, in killas and granite, and accompanied with quartz, pyroxene and axinite.

Staffordshire; with mesotype, in distinct concretions near the surface of a basaltic fault at Ponck Hill.

Gloucestershire (?); in globular concretions near Woodford Bridge.

Scotland. — Ayrshire; at Beith. Aberdeenshire; in the limestone quarries at Glen Gairden. Dumbartonshire; in the neighbourhood of Old Kilpatrick very abundantly, of a pale green or yellowish-green colour, in mammillated concretions, as at the Bolan quarry, half a mile N.E. of the town, and accompanied with analcime and Thomsonite. Edinburghshire; at Samson's Ribs, Arthur's Seat, flabelliform and of a yellowish-green colour, or greyish-white; at the Castle Rock, Edinburgh, along with pectolite in trap; it is, however, now scarce at this locality; of a fine yellow formerly at Salisbury Craigs, with analcime and datholite; orbicular and flabelliform at the great greenstone quarry on the north end of the Costorphine Hills; occasionally on the sea-shore near Leith. Near Glasgow; at Friskie Hall, of a fine sulphur-yellow colour. Renfrewshire; at Hartfield Moss near Paisley, white, opaque and radiated, accompanied with Cluthalite and analcime, not unfrequently assuming the form and appearance of the latter mineral; also with crystallized calc-spar and Greenockite at the railway tunnel near Bishoptown, in pale yellowish-green mammillations, engaged in a grey porphyritic greenstone. Stirlingshire; at the Campsie Hills, in trap, radiated globuliform, mammillated and crystallized as in the forms given in the figures, of a fine green colour, and often accompanied with Thomsonite. In the Island of Mull. At Rasay in Rona, of a white colour. In Skye; near Portree, and at the Cooleen Hills.

Ireland.—Recently, in small white radiating concretions in granite, on the east side of the Mourne Mountains.

94. ALLOPHANE, *Stromeyer*. Riemannite.

Reniform, encrusting, massive. Lustre resinous, vitreous. Colour pale blue; sometimes green, yellow-brown. Translucent. Fracture conchoidal and shining. Very brittle. H. 3·0; Gr. 1·86.

Analyses: *a*, from Gersbach, by Walchner; *b*, from Beauvais, by Berthier:—

	a.	*b.*
Silica	24·11	21·90
Alumina	38·76	29·20
Oxide of copper . .	2·33	. . .
Water	35·75	44·20
	100·95	4·70 (clay)
		100·00

Formula, $\overset{\cdots}{\bar{\mathrm{A}}\mathrm{l}}{}^3\overset{\cdots}{\mathrm{Si}}{}^2+15\dot{\bar{\mathrm{H}}}$?; with silica, 24·22; alumina, 40·39; water, 35·39.

In the open tube yields water. Before the blowpipe soon loses its colour, and becomes pulverulent, causing some intumescence, and tinging the flame green. With borax melts into a transparent and nearly colourless glass. Gives a jelly with acids.

Usually occurs lining cavities in marl or chalk. Has lately been observed as a British species by Dr. Krantz of Bonn, at the Charlton Hill chalk-pits near Woolwich in Kent.

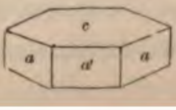
Note.—The allophane of New Charlton has been lately analysed by Mr. A. B. Northcote, with the following results (Phil. Mag. [4] xiii. 338):—

Silica	20·50	19·58	17·05
Alumina	31·34	37·30	32·88
Protoxide of iron . .	0·31	0·11	6·59 $\ddot{\mathrm{F}}\mathrm{e}$
Lime	1·92	1·36	1·34
Water	42·91	39·19	40·31
Carbonic acid . . .	2·73	2·44	1·82
	99·71	99·98	99·99

It is perhaps not as yet easy to assign any very definite chemical formula for this mineral. (See Silliman's Journal, No. 70, vol. xxiv. July, 1857.)

95. CHLORITE, *Phillips*; Talc Chlorite (in part), *Hauy*; Ripidolite, *v. Kobell.*

Rhombohedral. Cleavage *o* very perfect; crystals rare, usually in small plates or scales adhering together. Colour various shades of green, dark apple-green to greenish-grey. Lustre dull pearly; when in powder is unctuous to the touch. Thin laminæ easily flexible but *not* elastic, which serves to distinguish it from mica. Translucent. H. 1·5; Gr. 2·85.



c a 90° 00′
a a′ 120 00

Alone before the blowpipe only fuses on the edges, emitting a bright light. On charcoal fuses to a globule with difficulty; glass with borax coloured with iron. Thin laminæ are soluble in concentrated sulphuric acid.

Analyses: *a*, from Bute; *b*, from St. Gotthardt, by Varrentrapp; *c*, from Zillerthal, by Kobell:—

	a.	*b.*	*c.*
Silica	28·5	25·37	26·51
Alumina	19·6	18·50	21·81
Magnesia	16·0 (?)	17·09	22·83
Protoxide of iron . .	23·5	28·79	15·00
Water	11·4	8·96	12·00
	99·0	98·71	98·15

Formula, $\dot{\mathrm{R}}^9\dddot{\mathrm{Si}}^2+\dddot{\mathrm{Al}}^3\dddot{\mathrm{Si}}^2+9\dot{\mathrm{H}}$; if $\dot{\mathrm{Mg}}:\dot{\mathrm{Fe}}::1:1=$ silica, 27·2; alumina, 23·1; magnesia, 13·4; protoxide of iron, 24·2; water, 12·1.

Compact chlorite is amorphous, scarcely glimmering, and of an earthy texture. Chlorite forms the characterizing ingredient in chlorite slate; it is common in Cornwall with the tin veins, constituting with quartz the rock commonly known there as *killas*; the ordinary name for chlorite is *peach*. Chlorite occurs massive, investing, pseudomorphous, and disseminated.

LOCALITIES.—Cornwall; in the tin mines; in Cumberland and Westmoreland. Near Llanberris in N. Wales.

Scotland.—In Aberdeenshire; at Cairnie, and at Gaingomers. Banffshire; very fine and mixed with serpentine at Portsoy, where it is frequently cut and polished. Perthshire; crystallized at Glen Tilt. In the Islands of Bute, Arran, and Isla; very well crystallized (like the figure, and resembling the Piedmont variety) in Jura; at Carnebie in the Shetlands.

Ireland.—Co. Derry, Co. Down, Mourne Mountains. Kerry; near Killarney. Wicklow; at Glen Macannass. Donegal; at Dunfanaghy. Dublin; near Howth, in quartz.

Derived from χλωρὸς, *green*.

96. APHROSIDERITE, *Sandberger*. Ripidolite (in part).

Occurs in minute lustrous scales or laminæ, closely compacted, with quartz or calcite, and usually accompanied with specular-iron or Ilmenite. Colour dark olive-green. Easily decomposed by warm muriatic acid.

Analyses: *a*, by Sandberger, from Weilberg; *b*, by Hauer; *c* (ripidolite), from Dauphiny, by Marignac :—

	a.	*b.*	*c.*
Silica	26·45	26·08	27·14
Alumina	21·25	20·27	19·19
Protoxide of iron .	44·24	32·91	24·76
Magnesia . . .	1·06	10·00	16·78
Water	7·74	10·06	11·50
	100·74	99·32	99·37

Formula for analysis *a*, $(\frac{1}{2}\dot{\text{F}}\text{e}^3+\frac{1}{2}\ddot{\text{A}}\text{l})\dddot{\text{S}}\text{i}^{\frac{2}{3}}+\dot{\text{H}}$; with silica, 26·77; alumina, 21·53; protoxide of iron, 44·16; water, 7·54, being a ripidolite in which the magnesia is nearly all replaced by protoxide of iron, and with less water. Analysis *b*, by Hauer, comes very near ripidolite, as may be seen by comparing it with *c*.

Aphrosiderite can hardly rank as a distinct species, and may perhaps be considered a *ferruginous* ripidolite or chlorite.

Was recently observed by Dr. Krantz, of Bonn, on the large detached rock in the middle of the Penryn slate-quarry, Carnarvonshire. And probably, with Ilmenite and quartz at *Glen* Finnart in Argyleshire.

97. KÄMMERERITE, *Nordenskiold*; Ripidolite (in part). Rhodophyllite, *Genth*; Rhodochrome, *Rose*; Chrome-chlorite, *Hermann*.

Rhombohedral.? Hexagonal. Cleavage basal, perfect. Occurs foliated and massive, or granular. Lustre pearly. Colour reddish or violet, greyish. Translucent. Feel, greasy. Sectile. H. 1·5 to 2·5; Gr. 2·7.

In the open tube yields water. Exfoliates before the blowpipe, but only fuses on the edges.

Analyses: *a*, by Hartwell, from Siberia; *b*, by Hermann, from Siberia; *c* (rhodochrome), by Hermann; *d* (ripidolite), from Achmatowsk, by Kobell:—

	a.	*b.*	*c.*	*d.*
Silica	37·0	31·82	34·64	31·14
Alumina	14·2	15·10	10·50	17·14
Red oxide of iron . . .	...	...	2·00	...
Chromic acid	1·0	0·90	5·50	...
Lime	1·5	...	...	...
Magnesia	31·5	35·24	35·47	34·40
Oxide of nickel	...	0·25	...	...
Protoxide of manganese .	...	...	...	0·53
Protoxide of iron . . .	1·5	4·06	...	4·55
Water	13·0	12·75	12·03	12·12
	99·7	100·12	100·14	99·88

Formula, $2\dot{R}^3\dddot{Si}+\dddot{Al}\dddot{Si}+6\dot{\bar{H}}$; with silica, 37·6; alumina, 14·3; magnesia, 33·2; water, 14·9.

This mineral is undoubtedly merely ripidolite, coloured red by chromic acid. It was lately observed by Heddle, occasionally associated with chromate of iron and crystallized talc, at Haroldswick, Unst, Shetlands, crystallized in small hexagonal plates, and also foliated and granular.

98. MARGARODITE.—Talcite, *Thomson*. Hydrous Muscovite. Nacrite, *Thomson*; Gilbertite, *Thomson*.

Oblique.? Occurs in scales rather compactly aggregated, having a greasy feel like talc. Translucent, opaque. Lustre pearly. Colour white, grey, yellow, green. Friable. H. 2·7; Gr. 2·6 to 2·8.

With blowpipe, after ignition, becomes silvery-white and opaque, but retains its lustre.

Analyses: *a*, *Gilbertite*, from Cornwall, by Lehunt; *b*, by

Thomson, from Cornwall; *c*, *talcite*, from Wicklow, by Tennant; *d*, from Three Rock Mountain, Co. Dublin, by the Rev. S. Haughton; *e* (margarodite), from St. Etienne, France, by Delesse; *f*, Monroe, Connecticut, by Brush :—

	a.	*b.*	*c.*	*d.*	*e.*	*f.*
Silica	45·15	47·80	44·55	43·47	46·23	46·50
Alumina . . .	40·11	32·62	33·80	31·42	33·08	33·91
Peroxide of iron	...	...	...	4·79	3·48	2·69
Magnesia . . .	1·90	1·60	3·30	1·13	2·10	0·90
Lime	4·17	...	1·30	1·38	...	...
Soda	...	9·23	...	1·44	1·45	2·70
Potash . . .	...	...	...	10·71	8·87	7·32
Protoxide of iron	2·43	5·18	7·70	...	traces	0·82
Protox. manganese	...	...	2·25	...		0·31 (Cl)
Water	4·25	4·00	6·25	5·43	4·12	4·63
	98·01	100·43	99·15	99·77	99·33	99·78

Formula, $(\dot{R}^3\dddot{R})\dddot{Si}^{\frac{5}{4}}$; or more correctly $(\frac{1}{7}\dot{R}^3+\frac{6}{7}\dddot{R})\dddot{Si}^{\frac{5}{4}}$.

Mica appears at times hydrated, losing its elasticity and transparency, and often some portion of the alkalies and oxide of iron.

The hydrated micas from the granites of Dublin, Carlow, and Wicklow, contain, according to the Rev. S. Haughton (see Phil. Mag. for April, 1855), two atoms of water, and he assigns to them the formula $\dot{R},\dddot{Si}+2(\dddot{R}^2,\dddot{Si})+2\dot{H}$, which will probably suit many other hydrated micas. He further says the acute angles of the prisms are replaced, giving rise to hexagonal forms; and he gives the following as the angles between the optic axes of margarodite from several Irish localities :—

Three Rock Mountain	53°	8′
Glendalough	70	4
Mount Leinster	72	18
Lough Dan	70	0
Glen Malure	67	11

Localities.—Cornwall; at Stenna Gwynn near St. Austell, with granite and fluor, and of a yellowish-white colour, in considerable masses.

Cumberland; with apatite and tungstate of lime on quartz at

Caldbeck Fells; and at Brandygill, with corundum, in large masses of a pale yellowish-brown colour.

In Wicklow; in the form of, and investing, crystals of Andalusite (stated by Dr. Thomson in his 'Mineralogy' to be crystals of nacrite!), with quartz and mica-slate; in granite at Glendalough, Glen Malure, and Lough Dan; and similarly at Mount Leinster in Carlow, and at Three Rock Mountain, Co. Dublin.

99. TALC.—Soapstone. Talc Steatite. Speckstein. Lapis Ollaris. Chlorite Talc.

In thin six-sided plates. Cleavage basal, foliated, massive, amorphous. Lustre pearly; by transmitted light pale-green or grey; by reflected light frequently silver-white; also white, grey, brown, red. In thin laminæ flexible, but not elastic. Sectile. Unctuous to the touch, more so than chlorite; yields to the nail. H. 1·0 to 1·5; Gr. 2·7.

Nearly infusible before the blowpipe. Not acted on by acids; the greenish varieties lose colour. The compact white variety (steatite) hardens and becomes black before the blowpipe.

Analyses: *a*, foliated talc (resembling that from Unst), from Greiner, by Kobell; *b*, steatite, from Scotland, by Lychnell; *c*, pseudomorphous, by Scheerer; *d*, indurated talc, from Glognitz, by Scheerer:—

	a.	*b.*	*c.*	*d.*
Silica	62·8	64·53	62·07	62·47
Magnesia . . .	32·4	27·70	31·13	32·08
Protoxide of iron .	1·6	6·85	1·69	0·47
Alumina	1·0	...	0·39	0·13
Water	2·3	...	4·83	4·78
	100·1	99·08	100·11	99·93

Formula, $\dot{\text{Mg}}^6\dddot{\text{Si}}^5+2\dot{\text{Ħ}}$; with silica, 62·14; magnesia, 32·92; water, 4·94.

Foliated apple-green talc occurs in the Shetlands in considerable quantity, with crystals of Breunerite imbedded in it; as at Houbie, Norwick Bay, and Swinaness, in Unst; commonly with serpentine and calc-spar. In foliated and radiating masses of a brown colour, and slight silvery lustre, at Cairnie in Aberdeenshire. White and lamellar at Foxhall in Donegal.

Steatite.—Cornwall; with serpentine near the Lizard Point, but must not be confounded with the *saponite* found there.

Carnarvonshire; at Glydn Rock, Craig-y-Lebon near Penmorfa, and at Moel Shabot. In Anglesea; at Almwch.

Cumberland; with hæmatite near Egremont.

Herefordshire; at Holybush Hill.

Scotland.—Banffshire; at Portsoy with serpentine. Fifeshire; at Bogie quarry near Raith, of a pale bluish-green. Hebrides; at Scalpa; in Icolmkiln; and at Carnebie in Fetlar, Shetlands. Skye; near Dunvegan; and coloured red with manganese at the quarry of Strath.

Ireland.—Antrim; near the Causeway and Dunluce Castle, dendritic, opal-white, and pale-green. Donegal; in Banagh, and at the Kilmacrenan Mountains near Loch Swilly.

Potstone, or *Lapis Ollaris,* includes the coarser and more impure varieties of talc-steatite; colour greenish-grey with a feeble lustre; unctuous. Occurs at Polophant near Launceston in Cornwall, and of a pale leek-green colour on the banks of the Nithister, at Carnabie, and at Colafirth Voe in Fetlar, Shetland Isles. Also at Loch Fyne, south of Inverary in Argyleshire.

Indurated Talc is an impure slaty talc, with compact texture and superior hardness. Occurs in nodules at Little Cambray in Arran; at Portsoy in Banffshire; and Swinaness in Unst.

Talcose Slate, a dark greenish-grey slaty rock, having a somewhat greasy feel, consisting of talc intimately blended with felspar or quartz; it occurs plentifully at Portsoy in Banffshire.

100. LITHOMARGE.—Kaolin (in part). ?

Amorphous. Fracture conchoidal. Texture earthy. Adheres to the tongue. Has a greasy feel; yields to the nail, and has a shining streak. Opaque. Colour white, yellow, reddish; also blue or grey, and sometimes indurated or mottled. H. 2·0 to 2·5; Gr. 2·5.

Infusible before the blowpipe; sometimes phosphorescent when heated, and hardens after exposure to a high temperature.

Analyses: *a*, by Schüler, from Zwickau in Saxony; *b*, from the Hartz, by Dumenil; *c*, by Zellner, from Landshut; *d*, from Cook's Kitchen, near Redruth:—

	a.	*b.*	*c.*	*d.*
Silica	41·66	43·00	49·2	48·3
Alumina	22·85	40·25	36·2	36·4
Peroxide of iron . .	12·98	0·48	0·5	...
Lime	3·04	...	...	...
Magnesia	2·55	0·47	...	...
Oxide of manganese .	1·68	...	...	...
Potash	0·93	...	...	...
Water	14·20	15·50	14·0	14·5
	99·89	99·70	99·9	99·2

Under the name of lithomarge, several distinct substances are probably comprised, some mere results of decomposition: usually they are compact, earthy, unctuous, or pseudomorphous.

Localities.—Cornwall; said to occur at Tin Croft mine, Illogan, beautifully marked or speckled, and occurring in veins 15 inches thick traversing granite; and in smaller quantities at Cook's Kitchen, near Redruth; but possibly these are talc-steatite.

In Wicklow; of a brownish-yellow colour.

101. SAPONITE.—Soapstone. Thalite of *Owen*. Hydrous Steatite.

Amorphous. Soft, almost like butter, but grows harder on exposure. Colour white, grey, yellowish, also mottled. Does not adhere to the tongue. Gr. 2·6.

With blowpipe gives off water and blackens; thin splinters fuse with difficulty. Quite soluble in sulphuric acid.

Analyses: *a*, by Klaproth, *b*, by Svanberg, both from the Lizard, Cornwall; *c*, from Cornwall; *d*, by Smith and Brush (*thalite* of Owen), from the trap of Lake Superior:—

	a.	*b.*	*c.*	*d.*
Silica	45·00	46·8	42·10	48·89
Alumina	9·25	8·0	7·67	7·23
Peroxide of iron . . .	1·00	0·4	...	2·46
Magnesia	24·75	33·3	30·57	24·17
Lime, soda, and potash	0·75	0·7	...	0·81
Water	18·00	11·0	18·46	15·66
	98·75	100·2	98·80	99·22

Formula, $2\dot{Mg}^3\dddot{Si}^2+\ddot{Al}\dddot{Si}+10\dot{H}$; with silica, 45·56; alumina, 10·34; magnesia, 24·95; water, 18·15.

Localities.—Cornwall; it occurs in serpentine near the Lizard Point; at the Cheesewring near St. Cleer; and in considerable quantities three miles south of Mullion, on the coast, where is the celebrated soapstone rock called the Gue Graze. It is worked, and employed in the manufacture of porcelain.

A soft variety, which, like the above, hardens on exposure, occurs in the amygdaloidal rocks of Antrim; generally in nodules of a greyish, yellowish, or brownish colour; and at Magilligan, Co. Derry, it invests long crystals of calc-spar, which sometimes disappearing, leave a hollow tube; at the same place on the craigs, of a light blue colour, with Levyne.

102. KAOLIN.—Porcelain Earth. China Clay. Tuesite, *Thomson.*

Amorphous, earthy. Fracture uneven. Colour various shades of white or grey, inclining sometimes to blue, green, yellow, or brown. Feels meagre when dry, plastic when wet. Opaque, dull. Earthy, sectile, friable. H. 1·0 to 2·0; Gr. 2·25.

Before the blowpipe infusible. Not affected by muriatic acid, but is decomposed by warm sulphuric acid, which dissolves the alumina, and leaves the silica.

Analyses: *a*, from Devonshire; *b*, from Dartmoor; *c*, from do.; *d*, from Breage, Cornwall; *e*, from St. Stevens, Cornwall:—

	a.	*b.*	*c.*	*d.*		*e.*
Silica . . .	44·26	47·20	44·25	40·15		39·55
Alumina . .	38·81	38·80	36·81	36·20		38·05
Lime & potash	...	2·00	2·20	(9·50	and insoluble matter.	8·70)
Water . . .	12·74	12·00	12·70	11·65		12·50
	95·81	100·00	95·96	97·50		98·80

The composition may be expressed by the formula $\dddot{\mathrm{Al}}^3\dddot{\mathrm{Si}}^4+6\dot{\text{Ħ}}$; with silica, 47·03; alumina, 39·23; water, 13·74.

Kaolin is chiefly the product of the decomposition of felspathic granite, or of what is called *kaolin granite*; the felspar of the granite under certain circumstances parting with its alkalies and alkaline earths.

In the above analyses the free silica and undecomposed mineral were probably not separated; corrected, the proportion of water should be raised from 13 to 16.

A *kaolin* earth from Plympton gave, corrected,—

Silica	40·9
Alumina	44·5
Water	15·3
	100·7

This will give $\dddot{\mathrm{Al}}\dddot{\mathrm{Si}}+2\dot{\text{Ħ}}$; with silica, 40·0; alumina, 44·5; water, 15·5.

The *Tuesite* of Thomson is kaolin (see Supplement).

Localities.—The best kaolin is obtained in large quantity in Cornwall; in the parishes of Germoe and Breage near Helstone, and St. Stevens and St. Denis near St. Austell; and generally from Tregorming Hill, to a little south of Helstone.

It is also largely obtained, and of the finest quality, on the south side of Dartmoor in Devon, as at Plympton and Fownes.

In the Halkin Hills, Flint.

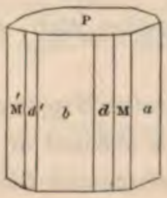
On the S.W. of Fetlar, one of the Shetlands.

Note.—In Breage and at Plympton, a large number of persons are engaged in the getting and preparation of china-clay; about 20,000 tons of prepared china-stone, and 60,000 tons of *china-clay*, are annually exported from thence, chiefly to the potteries; the average price is about 18*s.* a ton.

The first person who applied the china-clay of this country to the purposes of porcelain manufacture, was Mr. Cookworthy of Plymouth, in 1768.

103. PINITE.—Pinit, *Werner*. Cordierite (in part). ?

Pinite is supposed to be Cordierite more or less changed, an opinion to which many have been led, not only from the great similarity of its crystalline forms to those of Cordierite, but also from the general similarity of ratio in the alumina (with peroxide of iron) and the silica, which obtains in the two substances, the ratio in question being very nearly $3\ddot{\mathrm{Al}} : 5\ddot{\mathrm{Si}}$. Does not possess any regular structure or cleavage. Occurs in six- and twelve-sided prisms. Opaque. Lustre feeble. Dark-brown or blackish, grey, green, but the colours generally dirty. Fracture uneven and splintery. Streak white. Sectile. H. 2 to 3; Gr. 2·74 to 2·85.



M M'	119°	10'
M P	90	00
M *a*	120	25
P *r*	132	12
a b	90	00
a d	150	25
d d'	120	50

Combinations. P M *b a d*; P M *b a d r*: (*r* truncates M P).

In the matrass yields a little water. Before the blowpipe it melts on the edges, sometimes to a colourless, sometimes to a dark-coloured glass. Scarcely acted upon by hydrochloric acid, unless much altered, in which case it is in great part decomposed.

In composition it varies very considerably, the difference depending probably on the amount of alteration which the mineral has undergone. Rammelsberg observes, that it follows from the analyses by himself and others, that, as in Cordierite, the ratio of $\dddot{\text{R}}$ and $\dddot{\text{Si}}=3:5$, but that for the stronger bases, represented chiefly by potash, and for the water, no constant ratio can be established, for the reason that none such exists, and that consequently the composition will not admit of its being expressed by means of a formula. Should pinite, in truth, be altered Cordierite, the magnesia of the latter has been removed, and it has been replaced by more or less potash, with the further addition of water in varying quantity.

Analyses: *a*, from Penig, *b*, from Aue near Schneeberg, both by Rammelsberg; *c*, from Auvergne, by C. Gmelin (see Killinite):—

	a.	*b.*	*c.*
Silica	47·00	46·83	55·96
Alumina	28·36	27·65	25·48
Peroxide of iron	...	...	5·51
Protoxide of iron	7·08	7·84	...
Magnesia	2·48	1·02	(and $\dot{\text{Mn}}$ 3·76)
Lime	0·79	0·49	...
Potash	10·74	6·52	7·89
Soda	1·07	0·40	0·39
Water	3·83	7·80	1·41
	101·35	98·55	100·40

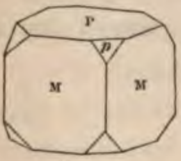
Localities.—*England.* Cornwall; at Lemorna Cove and in the felspathic granite rocks eastward of it, crystals small, dark-brown, of form of the figure. Terminal, or basal edges, also sometimes replaced by *r*. Common in the granite near Breage, and in that of Tol Peden Penwith near the Land's End. To S.E. of Trewellard near St. Just. At Mulvra Hill near Sancreed.

Scotland.—Perthshire; said to occur in porphyry at Blair Gowrie.

Ireland.—Dublin; in crystals three-quarters of an inch in length, near Dalkey.(?)

104. APOPHYLLITE. — Apophyllite, *Phillips*, *Brooke* and *Miller*, *Hauy*. Apophyllit of German authors.

Pyramidal. Primary form a right square prism. Cleavage parallel to P highly perfect, less so parallel to M. P smooth, with vitreo-pearly lustre; *r* sometimes curved, *a* slightly striated. Fracture imperfect conchoidal, or uneven. Transparent to translucent. Lustre vitreous. Colourless, white inclining to grey, also greenish, pink-red. Streak white. Brittle. H. 4·5 to 5; Gr. 2·3 to 2·4. Rammelsberg, however, cites a variety from the Harz (see analysis *c*), whose Gr. is only 1·96.



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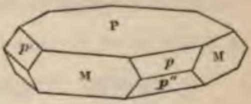

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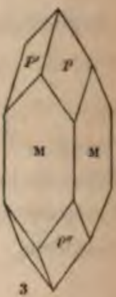

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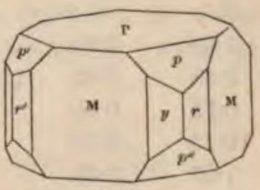


4

M M 90° 00′	M r 152° 26′	$p\,p'$ 104° 00′	$r\,r$ 143° 08
M P 90 00	P p 119 28	$p\,p''$ 121 04	

Scotch forms: M P; M *p*; M P *p*; M P *r*; M P *p r*.

The habit of the crystals varies extremely, according to the development of certain planes. When the planes *p* predominate, they assume a pyramidal character; when M, prismatic; when P, tabular.

In the matrass yields an abundance of water. Before the blowpipe it exfoliates, and melts with intumescence into a white blebby enamel. With salt of phosphorus yields a skeleton of silica. Many varieties give in the tube the reaction of fluorine. In powder easily soluble in hydrochloric acid, leaving a slimy siliceous residue; if previously exposed to a red heat, decomposed only with difficulty.

Analyses: *a*, from Faröe, *b*, from Utö, both by Berzelius; *c*, from Radanthal, in the Harz, by Rammelsberg:—

	a.	*b.*	*c.*
Silica . .	52·38	52·13	52·44
Lime . .	24·70	24·43	24·61
Potash .	5·37	5·27	4·75
Water . .	16·20	16·20	16·73
Fluorine .	1·20	(1·54 fluo-silicate	1·43 = 0·46 fluorine)
	99·85	99·57	99·96

$8\dot{C}a\ddot{S}i + \dot{K}\ddot{S}i^2 + 16\dot{\text{Ħ}}$; with silica, 52·43; lime, 25·86; potash, 5·36; water, 16·35, according to Naumann. G. Rose, in his 'Mineralsystem,' gives $(6\dot{C}a + \dot{K})\ddot{S}i + 2\dot{\text{Ħ}}$ as the formula for apophyllite. Till, however, the part played by the fluorine (which is present only in the proportion of 1 atom to 15 of silica) is well understood, it is hardly possible to express satisfactorily by means of a formula the result obtained by analysis. Rammelsberg appears inclined to suppose that the fluorine replaces a portion of the similarly electro-negative oxygen, and that this mineral is consequently a double silicate of lime and potash, in which a portion of the oxygen is replaced by fluorine, so that it contains a double salt of silico-fluoride of calcium and silico-fluoride of potassium.

Rose's formula, which requires silica 48·44, lime 25·60, potash 7·07, water 18·89, and $(\dot{C}a^8, \dot{K})\ddot{S}i + 2\dot{\text{Ħ}}$ of Rammelsberg, requiring silica 48·75, lime 26·72, potash 5·53, water 19·00, do not appear to us to agree so well with the analytical results as that which we have given above.

According to Wöhler, apophyllite is soluble in water at 180° to 190° Centigrade under a pressure of from 10 to 12 atmospheres, from which it crystallizes on cooling. Bunsen found that at the ordinary temperature not a trace of the mineral is soluble in water under a pressure of from 12 to 79 atmospheres.

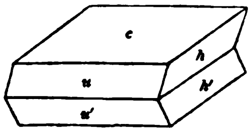
LOCALITIES.—*Scotland.* Argyll; at Strontian, sparingly. Dumbartonshire; at Bowling, with the form M *p*; at Old Kilpatrick, lately, in fine crystals of the form of figure 3. Fifeshire; formerly in good crystals, like figure 4, at the Chapel quarries near Raith. Inverness; in Skye, at Dunvegan; near Talisker, in very fine crystals of the primary form, white and nearly opaque, accompanied by scolezite: this variety of apophyllite is the *tesselite* of Brewster; at Talisker also, in large crystals of a palish green, in the form of figure 2, associated with mesotype and orbicular radiating pectolite; also the forms M P, M P *r*, M P *p r*; at Quirang, with the forms M P *p*, M P *p r*; at the Storr, in crystals sometimes two inches long by half an inch thick; near Loch Brittle; lately, along with pectolite, in very transparent crystals at Ratho near Edinburgh.

Ireland.—In Antrim, at Ballintoy, in soft wacke, of the form of figure 3, of a white colour, dispersed on stilbite. At Portrush in small, perfectly transparent crystals, of the primary form, with mesole, in cavities of the augitic rock; also in large crystals, white or slightly translucent, in the form of figure 1. Likewise near Portrush, at Agnew's Mountain, five miles west of Larne, in forms similar to those met with at Portrush.

The name apophyllite is derived from ἀποφυλλίζω, *to exfoliate,* alluding to its behaviour before the blowpipe.

105. PECTOLITE.—Pectolite, *Brooke* and *Miller*, *Dana*, *Beudant*; Soda-Wollastonite, *Thomson*; Pektolith, *Haidinger*, *Hausmann*, *Naumann*, v. *Kobell*.

Oblique. Primary form an oblique rhombic prism, and isomorphous with Wollastonite, as inferred from crystals lately obtained at Ratho quarry. Cleavage highly perfect parallel to *u*, less so parallel to *c*. These crystals, as does also the highly crystalline radiated variety from the Castle Rock, Edinburgh, afford very distinct cleavages of about 95° 25′ and 84° 35′, one of the principal cleavages of Wollastonite being 84° 37′. These cleavages are parallel to the faces *u* and *c* of Brooke and Miller's figure of Wollastonite, and coincide with the direction of the principal cleavages in that species. Rarely crystallised, usually divergingly fibrous; the fibres, however, sometimes admit of the cleavage being measured. Twins; twin-face *c*. The crystals are colourless and transparent; when fibrous the mineral is translucent to opaque. Lustre of crystals vitreous, of the fibrous varieties silky to dull. Fracture splintery. Very tough when fibrous. Colour white, tinged with greyish or yellowish-green. From some localities a minute fragment on being snapped in two in the dark emits a brilliant flash of light. H. 4 to 5; Gr. 2·7 to 2·88.



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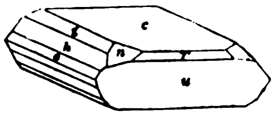


2

c u	84° 37′	*c i*	139° 30′	*c o*	102° 30′	*h u*	93° 30′
c n	132 54	*c h*	125 55	*c r*	159 30		

Combinations observed on Ratho crystals: *cuh*; *cuhi*; *cuionr*; *cuihonr*.

The forms *i*, *h*, *o* frequently hemihedral; crystals often twinned.

In the matrass yields a little water. Before the blowpipe it melts without intumescence into a transparent glass. With salt of phosphorus it is soluble, leaving a skeleton of silica. Decomposed by hydrochloric acid with a residue of viscid flakes of silica. When previously heated it forms a stiff jelly with hydrochloric acid.

Analyses: *a*, from Monzoni, by v. Kobell; *b*, in crystals, from Ratho, *c*, fibrous, from the same place, *d*, Castle Rock, Edinburgh, *e*, Knockdolian Hill, *f*, Girvan, *g*, Skye, all by Dr. Heddle; *h*, from Skye, by Scott; *i*, from Costorphine Hill, by Walker; *j*, from Bishoptown, *k*, from Kilsyth, both by Thomson; *l*, from Talisker, in Skye, by Heddle:—

	a.	*b.*	*c.*	*d.*	*e.*	*f.*
Silica . . .	52·34	52·58	52·53	53·06	53·24	53·48
Lime . . .	35·20	33·75	32·79	33·48	32·24	34·38
Soda . . .	9·66	9·26	9·75	10·27	9·57	9·87
Alumina . .	$\dot{\mathrm{K}}$ trace	1·45	0·89	0·46	1·00	0·41
Water . .	2·80	2·80	3·04	3·13	3·60	3·26
	100·00	99·84	98·99	100·40	99·65	101·40

	g.	*h.*	*i.*	*j.*	*k.*	*l.*
Silica . . .	53·82	52·00	54·00	52·07	52·74	53·82
Lime . . .	29·88	32·85	30·80	32·80	31·70	29·88
Soda . . .	9·55	7·67	5·55	9·60	9·60	9·55
Alumina . .	2·70	1·82	2·60	4·20	1·52	2·42
Magnesia .	...	0·39	...	...	...	0·31
Water . .	3·76	5·06	5·43	2·00	2·00	3·76
	99·71	99·79	98·38	100·67	97·56	99·74

$3(\dot{\mathrm{N}}\mathrm{a},\dot{\mathrm{K}})\dddot{\mathrm{S}}\mathrm{i}+4\dot{\mathrm{C}}\mathrm{a}^3\dddot{\mathrm{S}}\mathrm{i}^2+3\dot{\text{Ħ}}$, which requires silica, 52·57; lime, 34·95; soda, 9·68; water, 2·80. This formula, which is that of Berzelius, expresses, as will be observed, the constitution of crystallized pectolite, analysis *b*, with considerable accuracy. G. Rose, however, deems it improbable that the alkali and the lime should have different degrees of saturation, and suggests as the more natural the formula $2\{4\dot{\mathrm{C}}\mathrm{a}+(\dot{\mathrm{N}}\mathrm{a},\dot{\mathrm{K}})\}^3\dddot{\mathrm{S}}\mathrm{i}^2+\dot{\text{Ħ}}$, which nevertheless does not agree by any means well with the results obtained by analysis. Yet it is from this view of the matter that he is led to look on this mineral as a hydrous soda-Wollastonite; and though his formula can hardly be admitted, his idea as to the nature of this substance is probably correct. It at any rate affords an additional instance of the truth of the fact, first noticed by Professor Fuchs, that soda, with a certain amount of water, is capable of replacing lime. Frankenheim, on the other hand, is disposed to consider pectolite as a hydrous hornblende, and proposes for it the formula $4(4\dot{\mathrm{C}}\mathrm{a}\dddot{\mathrm{S}}\mathrm{i}^3)+(4\dot{\mathrm{N}}\mathrm{a}\dddot{\mathrm{S}}\mathrm{i}^3)+5\dot{\mathrm{H}}$, which, though tolerably correct as to the silica and bases, is less accurate with respect to the amount of water than is the formula suggested by Berzelius, and which latter is consequently the one adopted here.

LOCALITIES.—This mineral occurs in the trap and greenstone rocks in several parts of Scotland.

In Ayrshire; white, closely fibrous and in small acicular crystals at Knockdolian Hill near Ballantrae. Abundant on the shore near Landelfoot, in milk-white, fibro-crystalline translucent masses, affording a cleavage of about 95½°. This variety is called by dealers tremolite; its true nature is, however, shown by Dr. Heddle's analysis, given above under *f*. It here sometimes occurs in white fibro-crystalline radiations, nearly 3 feet in length! Edinburghshire; at the Ratho quarries near Edinburgh, at the depth of 90 feet, it occurs in large orbicular masses in greenstone, presenting a diverging structure. When first found it is very tough. Colour pale greenish-grey; lustre silky. After exposure to the air it often becomes white and soft, assuming somewhat the appearance of asbestus. It is from the summits of these radiating masses that the small transparent crystals were obtained which put it in the power of Dr. Heddle to make the satisfactory analysis of this species given above under *b*, and which also enabled the Authors to show the isomorphism of pectolite and Wollastonite. These crystals are rare. At the Costorphine Hills; in greenstone, compact and fibrous, yellowish-white with a tinge of grey. At the Castle Rock, Edinburgh; in nodular masses with a diverging structure, translucent and highly crystalline, of a pale yellowish-brown, with Prehnite. At Loch End; weathered. Inverness; at Prince Charles' Cave and Talisker, in Skye; in large orbicular masses, with fibrous diverging structure of pale greyish-green colour, and with silky lustre. It is accompanied at this locality by tabular crystals of apophyllite and by scolezite. Renfrewshire; at Bishoptown, compact and fibrous, in greenstone. Colour yellowish-white with a tinge of green. Stirlingshire; as above, at Kilsyth; this is Thomson's *Soda table-spar*.

The pectolite from some localities gives out a brilliant flash of light on being broken in the dark. A very small fragment from the Edinburgh Castle Rock locality is sufficient to show this. The phenomenon may be seen also with the Ratho mineral, in proportion as it is more or less crystalline. The Monzoni pectolite shows the same in a lesser degree.

The substance of pectolite occurs in the form of analcime. Dr. Heddle possesses a pseudomorph of this nature from the Ratho quarry.

The mineral from Ratho recently found its way into the hands of some collectors under the name of *Ratholite*; it is pectolite; as also a greenish-white radiating mineral on greenstone from Kilpatrick, sold as stellite, but which Dr. Heddle has proved to be natrolite. The *stellite* of Thomson is probably pectolite, an opinion which is confirmed by a recent inspection of a specimen in Dr. Thomson's collection. For a paper on Pectolite, see the Number of the 'Philosophical Magazine' fo April 1855.

The name pectolite is derived from πηκτὸς, *put together*, and λίθος, *a stone*.

106. GYROLITE.—Gyrolite, *Brooke* and *Miller*; Gurolite, *Anderson*; Gyrolith, *Naumann*, *v. Kobell*.

Cleavage in one direction easily obtained. Occurs in spherical lamellar radiations. Lustre when fresh, vitreous, becoming pearly by exposure to the air. Translucent when first met with, soon becomes opaque, or in thin plates only translucent. White; very tough. H. 3 to 4.

In the matrass yields water, intumesces and separates into thin scales, which have a silvery lustre. Before the blowpipe on charcoal it swells up, splits into very thin laminæ, and fuses with difficulty into an opaque enamel. With borax yields a transparent colourless glass.

Analysis of gyrolite by Dr. Anderson:—

Silica	50·70
Alumina	1·48
Lime	33·24
Magnesia	0·18
Water	14·18
	99·78

$3\dot{\mathrm{C}}\mathrm{a}\dddot{\mathrm{S}}\mathrm{i}+4\dot{\mathrm{H}}$; with silica, 53·29; lime, 32·86; water, 13·85. Occurs in spherical concretions composed of thin plates radiating from a centre, in the cavities of an extremely compact basalt at the Storr, about nine miles from Portree in Skye; also at Quirang and Lyndale. In Mull, near Loch Screden. This species when first exposed is, like other zeolites, perfectly transparent.

The name gyrolite has reference to the spherical disposition of the substance, and is derived from γῦρος, *a circle.*

Note.—Gyrolite is not exclusively a British species; specimens of it (arranged in Mr. Allan's collection as mesole by Haidinger) without doubt occur at Karartut, near Godhavn in Disco Island, Greenland; also at Niakomak, Omenenaksfiord, Disco; and according to Heddle in Faröe.

107. SERPENTINE, *Phillips, Werner*. Baltimorite. Williamsite, *Shepard*.

Massive. Fracture conchoidal, flat, uneven; possesses no distinct cleavage. Lustre resinous, feeble. Colour generally dark green, passing into yellow, red, or grey, also spotted or streaked. Translucent; opaque. Streak shining. Somewhat unctuous to the touch. Easily sectile. H. 3·0 to 3·5; Gr. 2·53.

In the matrass yields water and turns black. Before the blowpipe turns white, and melts with difficulty on the edges. Dissolves slowly in borax. In powder readily decomposed by sulphuric acid.

Analyses: *a*, from Ballinahinch, in Galway; *b*, from Snarum, by Scheerer; *c*, "Baltimorite," from Bare Hills, U.S., by Thomson; *d*, "Williamsite," from Pennsylvania, U.S., by Smith and Brush:—

	a.	*b.*	*c.*	*d.*
Silica	40·12	40·71	40·95	41·60
Magnesia . . .	40·04	41·48	34·74	41·11
Protoxide of iron.	3·47	2·43	10·05	3·24
$\dddot{\mathrm{Al}}$, $\ddot{\mathrm{C}}$, &c. . . .	2·00 $\dddot{\mathrm{Al}}$	2·39 $\ddot{\mathrm{C}}$	1·50 $\dddot{\mathrm{Al}}$	0·50 $\dot{\mathrm{Ni}}$
Water	13·36	12·61	12·66	12·70
	98·99	99·62	99·90	99·15

Composition: $\dot{\mathrm{M}}\mathrm{g}^9\dddot{\mathrm{Si}}^4+\dot{\mathrm{Ħ}}^6$; with silica, 43·64; magnesia, 43·35; water, 13·01.

Serpentine has been divided into the *noble* and *common* varieties, a division better understood than easy to define. When cut and polished it is used for a variety of useful and ornamental purposes. It usually constitutes extensive beds of rock, or even whole mountains; mixed with carbonate of lime it constitutes *verde antique*; native copper, chromic iron and asbestus, as well as steatite, are frequently disseminated in it. A fibrous variety, known in the United States as *Baltimorite*, occurs at Killin in Perthshire, dark green and *fibrous*.

The variety known as *Williamsite*, of a pale green colour, subtranslucent, and with a weak lustre and slaty fracture, has been observed by Dr. Heddle with chromate of iron at Haroldswick in Unst, one of the Shetlands.

LOCALITIES.—*England.* Cornwall; common serpentine is very plentiful near the Lizard Point, as at Kynance Cove, at the Balk, Cadgwith, Cliker Tor, Dranna, and Goonhilly Downs. At Polophant near Launceston, and at Duporth near St. Austell. Serpentine was formerly exported from Cornwall to Bristol for the manufacture of magnesia.

Anglesea; in the Parys copper-mine, and at Bullock's quarry.

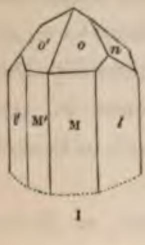
Scotland.—Ayrshire; at Ballantrae, and at Carleton Castle near Girvan. Aberdeenshire; in large quantities in the Alic Hills, and in the parish of Towie. Banffshire; very fine at Portsoy. At Durn Hill and Knock Hill. Inverness-shire; at Drumnadrochit near Loch Ness. Perthshire; at Killin. Shetlands; in Swinaness, in beds 4 feet thick.

Ireland.—In the Co. of Wicklow. Co. Mayo; near Westport. Co. Donegal; near Dunfanaghy. Co. Galway; at the Ballynahinch quarries very fine common serpentine and verde antique occur. At Birtirbuy.

108. TOPAZ, *Brooke* and *Miller, Dana, Phillips, Haidinger, Hausmann*; Topaze, *Hauy*; Topas, *Naumann, v. Kobell.*

Prismatic. Primary form a right rhombic prism. Cleavage highly perfect parallel to P; traces, especially in the Scotch varieties, parallel to M and *l*. Fracture conchoidal to uneven. Transparent to translucent on the edges. Lustre vitreous. Habit of the crystals always columnar, the prisms usually striated vertically. The Irish topazes slightly striated on M and *l*, parallel to their intersection with each other. Pyro-electric, the middle of P manifesting positive electricity on an increase of temperature, and the edges M M′ negative electricity.

Colourless, pink, brown, yellow, green, and blue, but all in pale tints at British localities. Streak white. H. 8; Gr. 3·4 to 3·6.



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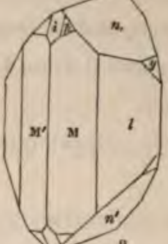

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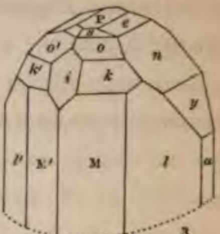

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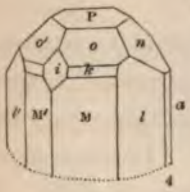

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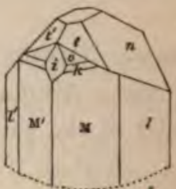


5

M M'	124° 19'	P *n*	136° 29'	P *i*	119° 05'	*l l'*	86° 52'
M P	90 00	P *y*	117 47	P *t*	146 03	*n n'*	87 01
M *a*	117 50	P *s*	145 53	*k i*	155 13	*o o'*	141 07
P *a*	90 00	P *o*	134 32	*k k'*	130 27	*t t'*	123 38
P *e*	147 41	P *k*	116 12	*l a*	136 24	*s s'*	149 38

The prevailing forms of the Mourne Mountain topazes are shown in figures 1, 2, 4 and 5. The ten following forms from the same locality occur also in Mr. Greg's collection: M *l n*; M *l n k*; M *l n o*; M *l n y k i*; M *l n y o k i*; M P *l y k i*; M P *l a y o k*; M P *l a n o k*, ...*y*....*i*....*t*. Figure 3 represents the form of a very fine Scotch crystal in the same collection; the combination M P *l n o y* occurs also. Scotch topazes sometimes contain cavities in which Sir David Brewster discovered two fluids, one of which expands a quarter of its original volume on a very moderate increase of temperature. At St. Michael's Mount, Cornwall, the form M *l n y*.

Exposed with salt of phosphorus to a strong heat in the open tube it gives indications of fluorine. Infusible before the blowpipe, but in a strong heat blisters rise on the surface and burst. Soluble in salt of phosphorus, leaving a skeleton of silica. With solution of cobalt becomes blue. Not acted on by hydrochloric acid. Digested for some time with sulphuric acid yields hydrofluoric acid.

Analyses: *a*, from Saxony, by Berzelius; *b*, from Trumbull, Connecticut; *c*, from Finbo, both by Forchammer:—

	a.	*b.*	*c.*
Silica	34·24	35·39	35·66
Alumina . . .	57·38	55·96	55·16
Fluorine . . .	14·99	17·35	17·79
	106·61	108·70	108·61

$6\dddot{\mathrm{Al}}^3\dddot{\mathrm{Si}}^2+(3\mathrm{AlFl}^3+2\mathrm{SiFl}^3)$; corresponding to silica, 35·52; alumina, 55·33; fluorine, 17·49=108·34, as obtained by analysis, a result which represents silicon, 17·07; aluminium, 29·49; fluorine, 17·49; oxygen, 35·95=100.

Usually in attached, seldom in imbedded, crystals, massive or disseminated, in veins and druses in granite, gneiss and porphyry, often associated with beryl, cassiterite, and lepidolite.

Localities.—*England.* Cornwall; in small bluish-white crystals, of the general form of figure 2, but without the faces *i*, *k*, with crystallized cassiterite, at St. Michael's Mount. At the granite quarries of Constantine and Mabe. At St. Austell Hill mine. In clay-slate at Wheals Kind and Trevannance, near St. Agnes. At Kea.

Scotland.—Aberdeenshire and Banffshire; magnificent topazes have occurred in the Cairngorm district, occasionally in transparent rolled crystals, and masses of a pale blue colour 3 or 4 inches in diameter. Professor Jameson alludes to one weighing 19 ounces. The Aberdeenshire localities lie mostly on the east side of Lochanger Mountain near Balmoral. Small crystals have been found lately on Ben Aven; near Braemar, in ravines, rolled crystals are occasionally found by the shepherds.

Crystals of topaz occur also in druses, with black or brown rock crystals, on the east side of Loch Aven. Hebrides; said to occur in good crystals in that part of Lewis called Harris. There is a peculiarity in the disposition of colour in the Scotch topazes: their prevailing hue is pale blue, but there is a tinge of reddish-brown along the acute edges of the prism. Of this the lapidary can avail himself in order to cut from the same crystal stones of more than one colour.

The finest specimens known of Scotch topazes are in the collection of Mr. Farquarson of Invercauld, in that of Mr. Greg, and in that belonging to the University of Edinburgh.

Ireland.—Downshire; in the Mourne Mountain district. On Slieve Corragh (in Corragh hamlet ?), with very perfect crystals of blue beryl, albite, smoky quartz, and lepidolite. The topazes from this locality seldom exceed an inch in length, but are frequently doubly terminated; they are usually colourless, or have a very faint tinge of pink, blue or green. The prevailing forms have been already mentioned.

Mr. Patrick Doran has been lately successful in again obtaining good specimens from this locality.

The name topaz is derived from Τόπαζος, an island in the Red Sea, whence, however, not the topaz, but the chrysolite is said to have been obtained.

109. CHONDRODITE, *Hauy*; Humite, *Phillips* and *Bournon*; Brucite, *Cleaveland*.

Prismatic ?. Oblique ?. Cleavage indistinct; usually in imbedded grains or masses of a somewhat granular texture. Lustre vitreous, resinous. Colour yellow, yellowish-brown. Translucent. Fracture small, conchoidal, uneven. Streak white. H. 6·0 to 6·5; Gr. 3·2.

An analysis of a yellow variety from New Jersey, gave Rammelsberg :—

Silica	33·06
Magnesia	55·46
Protoxide of iron . . .	3·65
Fluorine	7·60
	99·77

Formula, $\text{Mg}\cancel{\text{F}}\text{l}+2\dot{\text{Mg}}^{3}\ddot{\text{Si}}$; with silica, 37·28; magnesia, 50·06; magnesium, 5·11; fluorine, 7·55: part of the magnesia is replaced by $\dot{\text{Fe}}$.

In the open tube, with salt of phosphorus, yields the reaction of fluorine. Infusible alone. Soluble in muriatic acid, leaving a jelly of silica. Yields glass with borax.

Occurs in small crystalline masses of a brownish-yellow colour in granular carbonate of lime, with magnetic and arsenical pyrites, near Loch Ness in Scotland. Similarly in crystalline Dolomite near Gweedore, Co. Donegal, in Ireland.

The name of chondrodite is from *χόνδρος, a grain,* alluding to its granular structure.

110. LEPIDOLITE.—Lepidolite, *Brooke* and *Miller, Dana*; Lithion Mica. Mica (in part), *Hauy*; Lepidolith, *Hausmann*; Lithionglimmer, *Naumann*; Lithionit, *v. Kobell*; Zinnwaldit, *Haidinger.*

Oblique?. Prismatic?. Occurs often in oblique rhombic and hexagonal prisms, and in coarsely granulated masses consisting of foliated scales. Cleavage basal, very perfect. Fracture conchoidal, but seldom observable. In thin leaves flexible and highly elastic. Tough. Lustre on basal plane pearly, inclining to adamantine, on the other faces vitreous. Of various shades of white, grey, yellowish, green, rose-red, violet. Frequently silver-white by reflected light, rose-red by transmitted light. H. 2 to 3; Gr. 2·8 to 3·1.

Biaxial; apparent angle of optical axes 70° to 78°.

In either the matrass or the open tube yields the reaction of fluorine. Before the blowpipe melts *very easily* with effervescence into a colourless, brown, or black glass, the colour of the flame being tinged purple. This colouring of the flame is rendered still more readily visible after a little mixed fluor and bisulphate of potash have been added to the assay. With salt of phosphorus leaves a skeleton of silica. As found, but little acted upon by acids; after previous fusion it is, however, completely decomposed.

Analyses: *a*, from Zinnwald, by C. Gmelin, *b*, from same place, *c*, from Cornwall, *brown*, *d*, from Cornwall, *grey*, all three by Turner; *e*, from Rozena, by C. Gmelin; *f*, by Rammelsberg:—

	a.	*b.*	*c.*	*d.*	*e.*	*f.*
Silica	46·23	44·28	40·06	50·82	49·06	51·70
Alumina . . .	14·14	24·53	22·90	21·33	33·61	26·76
Peroxide of iron	17·97	...	27·06	...	...	...
Protoxide of iron	...	11·33	...	9·08	...	...
Protox. mangan.	4·57	1·66	1·79	trace	$\dddot{\bar{M}}n$ 1·40	$\dddot{\bar{M}}n$ 1·29
Lime	...	...	...	...	...	0·40
Magnesia . . .	...	...	...	...	0·41	0·24
Potash . . .	4·90	9·47	4·30	9·86	4·19	10·29
Lithia	4·21	4·09	2·00	4·05	3·59	1·27
Soda	...	...	...	...	...	1·15
Hydrofluor. acid	8·53	5·14	2·71	4·81	3·45	Fl 7·12
Phosphoric acid	...	...	...	...	0·11	0·16
Water . . .	0·83	...	...	...	and loss 4·18	...
	101·38	100·50	100·82	99·95	100·00	100·38

From these analyses it will be seen that the composition of different lepidolites varies very considerably. Rammelsberg is of opinion that in this mineral, as in topaz and apophyllite, the fluorine partially replaces oxygen, whence he conceives that the composition of the different varieties of lepidolite may be represented by the general formula $m\dot{R}\dddot{Si}+n\dddot{\bar{R}}\dddot{Si}$, m and n being for the most part each$=1$, in some $m=2$ and n 3, in others $m=3$ and n 2, a portion of the bases, and likewise of the acid, being also, as he imagines, not oxygen, but fluorine compounds. Much as lepidolites vary in composition, there are, however, some distinguishing points in their constitution, among which may be mentioned the presence of a considerable amount of fluor, ranging from 2 to 8 per cent., and of lithia, varying from 2 to 5 per cent., the latter being decidedly characteristic of the species, though in absolute quantity exceeded by potash. The red varieties contain only oxide of manganese and no peroxide of iron.

It occurs principally in granite, taking the place of mica, and in beds and veins in granite and gneiss.

Localities.—*England.* Cornwall; in silver-coloured hexagonal plates, with topaz and cassiterite, at St. Michael's Mount.

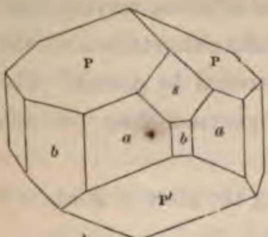
Scotland.—Argyll; in primitive limestone at a quarry on the east side of Loch Leven, opposite the inn at Ballichulish. Reported to occur at Dalmally.

Ireland.—Tyrone; in small plates, of a dull pink, in the parish of Termonmaquirk. ? Of a whitish colour at Holly Hill near Strabane.

The name lepidolite is derived from λεπίδιον, *a small scale.*

111. TOURMALINE, *Phillips*, *Hauy*. Aphrite. Schorl. Zeuxite, *Thomson*. Rubellite. Indicolite.

Rhombohedral. Cleavage P and *s* imperfect; *b*, *a* striated vertically; *o* usually smooth and brilliant; *o* at the opposite end dull; *e*, *s*, *t*, *b* usually hemihedral, with inclined faces; *s*, *t* occur at one end of the crystal, and *o*, *e* at the other. Prisms often triangular, owing to the alternate faces *b* being small or absent. Fracture imperfect conchoidal, uneven. Massive columnar, radiating and diverging, as well as in detached crystals. Lustre vitreous. Colour black, brown, red, blue: the same individual sometimes exhibits different colours. Brittle. Pyro-electric. While cooling, the extremity of the crystal on which the hemihedral faces *s* occur (figure 2) acquires vitreous electricity; and the other extremity, on which the hemihedral faces e' occur, acquires resinous electricity[*]. H. 7·0 to 7·5 ; Gr. 3·0 to 3·3.



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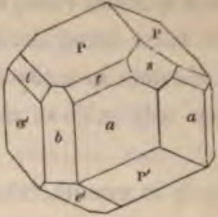

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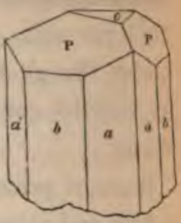


3

P P	133° 08′	P *s*	141° 30′	*a a′*	120° 00′	*s o*	134° 02′
P′ *e′*	156 34	*a s*	128 30	*a b*	150 00	*e e′*	154 59
P *o*	152 40	*a t*	142 26	*b b*	120 00	P *a*	113 26

Before the blowpipe the Bovey Tracey black tourmaline intumesces and becomes a black scoriaceous mass. With borax fuses and gives the reactions of iron and silica. With soda yields the reaction of manganese; with fluor spar imparts a green colour to the flame. After fusion is decomposed by concentrated sulphuric acid. The red varieties contain no iron, but a little lithia and oxide of manganese; the yellow and brown varieties contain little iron, but a good deal of magnesia; the blue and green varieties, iron, lithia, and oxide of manganese; the black varieties contain most iron.

[*] On being rubbed, tourmaline becomes positively electric; and, exposed to heat, usually acquires positive electricity at that end of the crystal which has the greatest number of facets, and opposite polarity at the other.

The face *s* belongs to the *antilogue* electric pole, and is that end usually presenting the greatest number of facets; the face *e* belongs to the *analogue* electric pole.

Becquerel says of the tourmaline,—"At 30° C., electrical polarity was sensible; it continued to 150° as long as the temperature continued to rise; if stationary an instant, the polarity commenced to decline. If one end of the crystal was heated, the crystal was unpolarized; and when the two sides were unequally heated, each acquired an electrical state independent of the other." Exposed to intense cold, the polarity is reversed. If a prism of tourmaline be broken when in a state of excitation from heat, each fragment presents two opposite poles, in the same manner as the artificial magnet.

Analyses: *a*, of a Bovey Tracey tourmaline, Gr. 3·205, by Rammelsberg; *b*, by Gmelin; *c*, from New Hampshire, by Rammelsberg:—

	a.	*b.*	*c.*
Silica	37·00	35·20	38·33
Boracic acid . .	7·66	4·11	9·86
Alumina . . .	33·09	35·50	33·15
Peroxide of iron .	9·33	17·86	3·07
Protoxide of iron .	6·19		0·12
Magnesia . . .	2·58	0·70	10·89
Lime	0·50	0·55	0·77
Soda	1·39	2·09	1·52
Potash	0·65 $\ddot{Mn}$	0·43	
Phosphoric acid .	0·12	...	0·24
Fluorine . . .	1·49	...	2·50
	100·00	96·44	100·45

General formula, $(\dot{R}^3,\dddot{\bar{R}},\dddot{B})\dddot{Si}^{\frac{5}{4}}$; the oxygen ratio between the silica and the other ingredients is constant, but the oxygen ratio for protoxides, peroxides, and boracic acid varies greatly.

Analyses, *a* and *b* constitute what may be termed an *iron tourmaline.* For other analyses and chemical information respecting tourmaline, see Dana's 'Mineralogy,' 4th Edition, and Rammelsberg's 'Supplements.'

Localities.—*England.* Magnificent crystals of black tourmaline, with the form of figure 1, occurred many years since in a granite quarry at Chudleigh, near Bovey Tracey in Devon, associated with fine translucent crystals of white apatite.

Cornwall; near St. Just, in black crystals like figures 2 and 3; similarly at Roscommon Cliffs; at Botallack mine; at St. Michael's Mount, and at the Logan Stone; near St. Day and St. Ives; near the viaduct in Luzullion parish: a brown fibrous variety once occurred in Cornwall in quartz rock, which has sometimes been passed off as Cronstedtite; small transparent colourless crystals occur at Roscommon Cliffs near St. Just.

Green schorl occurs in white granite at Oakhampton, near Dartmoor in Devon.

Cumberland; at Tenter Gill, Carrock Fells; also at Saddleback near Force Crag.

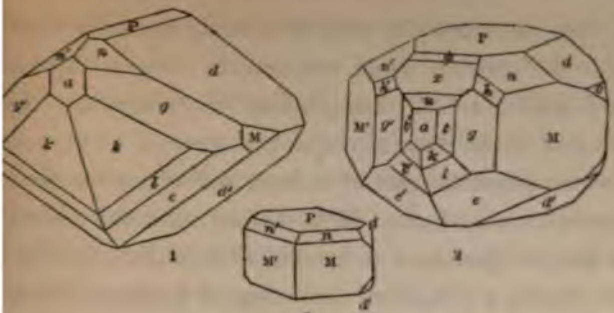
Scotland.—Aberdeenshire; terminated crystals several inches in length occur at the Rubislaw quarries near Aberdeen, in granite; in the parish of Towie; near Portsoy in Banffshire; and occasionally in Perthshire, Inverness-shire, and Argyleshire; in granite at Scuir Marxy in Ross-shire.

Ireland.—Co. Dublin; at Three Rock Mountain, at Dalkey, in large prismatic dark brown crystals; with quartz and felspar at Killiney, and with beryl, in long slender black crystals at Stillorgen. Co. Donegal; in green crystals near Dunfanaghy. Londonderry; at Sawel, near Dungiven, in mica-schist. In granite in the counties of Louth and Leitrim. At Ox Mountain, near Sligo, according to Patrick Doran, in fine crystals of a red and green colour (*rubellite*). Near Roundwood, and in Glen Malure, Co. Wicklow.

The *zeuxite* of Thomson is merely an iron tourmaline (see 'Philosophical Magazine,' August, 1855) formerly found at Huel Unity, and occurring in small translucent and acicular greenish-black crystals much interlaced.

112. DATHOLITE.—Datholite, *Brooke* and *Miller*, *Dana*, *Phillips*; Chaux boratée silicieuse, *Hauy*; Datolith, *Haidinger*, *Hausmann*, *v. Kobell*, *Naumann*; Humboldtite, *Levy*.

Oblique. ? Primary form an oblique rhombic prism. Cleavage parallel to *a*, but not easily obtained; traces parallel to M. Twins. Twin-face *a x* striated. Fracture uneven to conchoidal. Translucent to transparent. Lustre vitreous, on fracture resinous. Colour white inclining to greenish- or yellowish-grey. Streak white. Brittle. H. 5 to 5·5; Gr. 2·9 to 3.



1 2 3

103° 16′	P *d*	147° 43′	P *n*	38° 51′	*a k*	154° 41′
90 04	P *o*	128 23	P *x*	135 00	*a l*	149 24
128 22	P *k*	68 48	P *u*	116 34	*a n*	112 55
90 00	P *l*	64 33	*a e*	130 13	*a t*	157 10
156 30	P *e*	49 47	*a g*	147 43	P *h*	112 55

rms: *ag*M*dne*; *ag*M*dne*P*lk*; PM*dn*. *β* replaces lge P *d*, and not before observed.

the matrass yields water. Intumesces before the blowpipe, nelts readily to a clear glass, the flame being coloured . Soluble in salt of phosphorus, leaving a skeleton of In powder easily decomposed in hydrochloric acid, ıg a jelly of silica. Alcohol added to the solution, evaed to dryness, burns with a green flame.

alyses: *a*, from Arendal, *b*, from Andreasberg, both by nelsberg; *c*, from Andreasberg, by Kerl; *d*, from Glen by Heddle:—

	a.	*b.*	*c.*	*d.*
ica	37·52	38·48	37·89	38·08
ne	35·40	35·64	34·87	35·68
racic acid . .	20·70	19·99	21·65	20·32
ter	5·71	5·57	5·59	5·64
	99·33	99·68	100·00	99·72

$\mathrm{a}\dddot{\mathrm{B}}+\dot{\mathrm{C}}\mathrm{a}^3\dddot{\mathrm{S}}\mathrm{i}^4+3\dot{\mathrm{H}}$; silica, 37·91; lime, 35·07; boracic 21·48; water, 5·54=100. This formula contains, as nelsberg observes, an unusual and even improbable silicate, ıe therefore proposes to look on the boracic acid, not as an acid, but as acting the part of a base, in which view of the matter the formula would assume the simple expression of $2\dot{Ca}^3\dddot{Si}+\dddot{B}^3\dddot{Si}^2+3\dot{\text{Ħ}}$. Rose, in his 'Mineralsystem,' takes another view of the constitution of this species; he supposes that the water plays the part of a base, and writes the formula as follows: $3(\dot{Ca}\dddot{B}+\dot{Ca}\dddot{Si})+\dot{\text{Ħ}}^3\dddot{Si}$, adding, that datholite may be also looked upon as a compound of $2\dot{Ca}^3\dddot{Si}^2+3\dot{\text{Ħ}}\dddot{B}$, or, in other words, a compound consisting of 2 atoms Wollastonite and 3 atoms sassoline, if indeed combinations of this nature were admissible.

Occurs generally in trap or amygdaloidal rocks, occasionally in gneiss or transition limestone. Usually in attached crystals; sometimes columnar, granular, massive.

Localities.—*Scotland.* Dumbartonshire; in small distinct crystals in basaltic greenstone at the Kilpatrick Hills. Edinburghshire; in the trap-rock cut into in constructing the road round Salisbury Craig. The crystals are generally minute; but in the Earl of Cathcart's collection there is a specimen from this locality on which the crystals, which are translucent and of a pale greenish yellow, are three-quarters of an inch in length. On Costorphine Hill in colourless crystals. Lanarkshire; a few finely crystallized specimens, engaged on Prehnite, were met with in cutting the railway tunnel near Bishoptown. Perthshire; at Glen Farg, in small crystals, and also granular, with analcime; the faces *d, g* and *k* are much enlarged: fig. 1 represents a crystal from this locality in Mr. Greg's collection, and *a g* M *d n e* a form in Dr. Heddle's collection. What has been called *Haytorite* is pseudomorphic chalcedony in the form of datholite. It was met with some years ago at the Haytor Iron mines in Devonshire. One of the forms of Haytorite is represented by figure 2, from a crystal likewise in Mr. Greg's collection; and Miller describes also the forms *a* P *t g* M *d o n e h u k x*; *a* P *g e x* $\theta\ \phi\ \psi$, twinned.*

The form β occurred on a crystal of Haytorite recently procured by Mr. Renfree of Penzance, from N. Roskear mine. The form P M *d n*, in small crystals, figure 3, has been lately found by the Rev. Dr. Fleming of Edinburgh, in cavities of compact radiating Prehnite in the Isle of May, Firth of Forth.

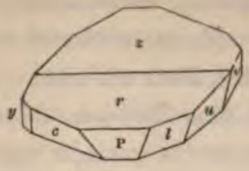
The name datholite is derived from δατέομαι, *to part, to subdivide*, and λίθος, with reference to the granular separation of the non-crystallized varieties.

Note.—The primary form of datholite has long been a subject of dispute among mineralogists, Levy having considered it to be oblique, and Brooke that it was prismatic. The supposed hemihedralism of some of the forms of datholite, as *e l k n x*, induced Messrs. Brooke and Miller to consider its primary to be prismatic and not oblique. M. Senarmont, however, states (Ann. des Mines [5], viii. 497), that when crystals are sliced precisely parallel to the terminal plane P, and examined by polarized light, the colours spread most on one side instead of being uniform around, showing that beyond doubt the prism is *oblique*, and not a right prism. M. Schröder and M. Descloiseaux also support this opinion.

113. AXINITE, *Brooke* and *Miller*, *Dana*, *Phillips*, *Hauy*; Axinit, *Haidinger*, *Hausmann*, *v. Kobell*, *Naumann*.

Anorthic. Primary form a doubly oblique rhombic prism. The crystals met with in Great Britain often appear very unsymmetrical; in Dauphiny not unfrequently far less complicated forms appear. Cleavage indistinct parallel to P and *v*. Colour usually clove-brown of various shades. Lustre vitreous. Transparent to translucent on the edges. Exhibits trichroism in a remarkable degree. "On looking through a crystal in the direction of either optic axis, a dark violet stripe is seen, interrupted at the point occupied by the axis." Fracture small, conchoidal. Becomes electric by friction or heat. The faces

P, *l*, *u*, *r* are usually striated. Brittle. H. 6·5 to 7; Gr. 3 to 3·3.



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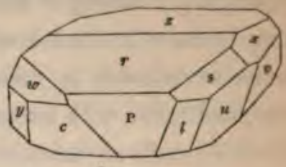

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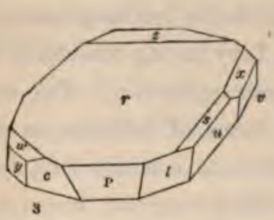

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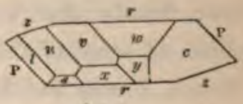

3 *a*

P *c* 113° 15′	P *u* 135° 25′	*r y* 85° 35′	*u s* 152° 01′
P *l* 151 03	P *v* 102 30	*r s* 143 38	*v y* 139 09
P *z* 116 26	P *w* 119 50	*r v* 93 14	*w y* 151 30
P *y* 96 32	P *x* 130 28	*r w* 114 30	*x y* 126 25
P *r* 134 48	*l u* 153 25	*r x* 139 12	*c y* 156 20
P *s* 146 39	*r c* 85 40		

Forms: P*rzcvluy*; P*rzcvluywsx*.

Before the blowpipe fuses readily, with intumescence, into a dark green glass, which in the oxidating flame becomes black, owing to the further oxidation of the manganese which it contains. With borax gives a bead, which indicates the presence of iron, and in the oxidating flame shows the violet colour due to manganese; gives also with soda the reaction of manganese, with fluor and bisulphate of potash that of boracic acid. After fusion, not before, however, is completely dissolved in hydrochloric acid, leaving a jelly of silica.

Analyses: *a*, *b*, *c*, from Bourg d'Oisans, *d*, from the same place, to ascertain the amount of peroxide of iron and of the boracic acid, all by Rammelsberg:—

	a.	*b.*	*c.*	*d.*
Silica	43·47	43·68	not det.	. . .
Alumina	16·30	15·63	17·17	. . .
Peroxide of iron . . .	10·25	9·45	9·31	8·26
Oxide of manganese . .	2·74	3·05	2·94	. . .
Lime	19·90	20·67	20·00	. . .
Magnesia	1·55	1·70	1·94	. . .
Potash	not det.	0·64	0·11	3·40
Boracic acid		5·61	not det.	. . .
		100·43		

$(\dot{\mathrm{C}}\mathrm{a},\dot{\mathrm{M}}\mathrm{g})^3(\dddot{\mathrm{S}}\mathrm{i},\dddot{\mathrm{B}})^2+2(\dddot{\bar{\mathrm{A}}}\mathrm{l},\dddot{\bar{\mathrm{F}}}\mathrm{e},\dddot{\bar{\mathrm{M}}}\mathrm{n})(\dddot{\mathrm{S}}\mathrm{i},\dddot{\mathrm{B}})$; silica, 43·93; alumina, 16·29; peroxide of iron and oxide of manganese (uniting them in consequence of the equality of their atomic weights), 12·68; lime, 19·98; magnesia, 1·58; boracic acid, 5·54=100. With respect to the boracic acid, Rammelsberg observes that no method is as yet known for ascertaining its amount correctly, but that from the nature of the processes employed, it must be less than 5·6 per cent., and more than 3·40.

In the above formula it will be observed that the isomorphism of silica and of boracic acid is taken for granted, of which, however, we have, as Rammelsberg says, no positive proofs as yet. Possibly the boracic acid may in axinite (as Rammelsberg is inclined to think he has established to be the case with respect to datholite) play the part of a base, in which view the formula would assume the following form:—

$$2,\left[\left.\begin{matrix}\dot{\mathrm{C}}\mathrm{a}^3\\ \dot{\mathrm{M}}\mathrm{g}^3\end{matrix}\right\}\dddot{\mathrm{S}}\mathrm{i}+2\left.\begin{matrix}\dddot{\bar{\mathrm{A}}}\mathrm{l}\\ \dddot{\bar{\mathrm{F}}}\mathrm{e}\\ \dddot{\bar{\mathrm{M}}}\mathrm{n}\end{matrix}\right\}\dddot{\mathrm{S}}\mathrm{i}\right]+\dddot{\mathrm{B}}\dddot{\mathrm{S}}\mathrm{i}.$$

Rammelsberg, however, states in his first 'Supplement,' that Berzelius preferred the first formula of the two here given.

In attached crystals and massive, usually in veins or beds in granite, gneiss, mica-slate and clay-slate.

Localities.—*England.* Cornwall; very perfect crystals, with the forms given in the figures 1 and 2, of a dark clove-brown, sometimes 1½ inch across, have been found at Botallack and Trewellard, near St. Just. Also at Carn Silver near Lamorran Creek. At Wheal Cock. In crystals of a light grey colour, inclining to violet, in the hornblende slates of Boscawen Cliffs in St. Burien. At Carharrack, St. Day.

Devonshire; at Brent Tor, four miles north of Tavistock. Pseudomorphous crystals of chlorite, in the form of axinite, are met with on Dartmoor. They have the exact form of the crystals from near St. Just. It is to Mr. H. Bullen of Tavistock that the Authors are indebted for the knowledge not only of this remarkable pseudomorph, but also for their acquaintance with several good localities of choice minerals met with in the Tavistock district.

N.B.—In the Cornish crystals, the forms *c*, *v*, P, *r*, *z* usually predominate, while the faces *y* and *c* appear to be peculiar to that locality.

Order XII. ALUMINA AND ALUMINATES.

114. CORUNDUM, *Phillips*. Sapphire. Corindon, *Hauy*.

Rhombohedral. Hexagonal forms prevail. Cleavage P and *o* more or less perfect. Fracture conchoidal, uneven. Lustre vitreous, sometimes pearly or satiny in some directions. Colourless, blue, grey, red, white. Transparent, opaque. H. 9·0; Gr. 3·9 to 4·1.

Infusible before the blowpipe either alone or with soda. Soluble in borax with difficulty, forming a transparent glass not acted on by acids.

Analysis by Klaproth:—

Alumina	98·5
Red oxide of iron	1·0
Lime	0·5
	100·0

Composition: $\ddot{\mathrm{Al}}$; aluminium, 53·19; oxygen, 46·81.

The transparent blue and red varieties are called sapphire and ruby respectively, and usually occur in rolled grains and crystals in river-sands in Ceylon. The rough crystals and cleavable masses are commonly called *corundum*, and the granular and massive varieties *emery*.

Localities.—*England.* Lately found, in opaque bluish-grey hexagonal crystals, in nacrite, by Mr. Bruce Wright, at Carrock Fells in Cumberland. Mr. Mallet, lately of Dublin, has observed small rolled fragments of corundum, having a blue colour, scratching topaz and chrysoberyl, sp. gr. 3·98, in the bed of a stream having its source in the Croghan Kinshela Mountains, in the Co. of Wicklow.

The corundum mentioned in Sowerby's 'British Mineralogy' as occurring at Auchindoir in Aberdeenshire, is red schorl.

Emery-stone is said to occur in the Island of Jersey; at Madron in Cornwall; and at the base of one of the Mourne Mountains, Co. Down.

115. SPINEL.—Spinelle Ruby. Ceylanite. Pleonaste.

Cubic. Cleavage octahedral. Lustre vitreous, brilliant to dull. Colour red, passing into blue, green, black, yellow. Streak white. Transparent, opaque. Fracture conchoidal. Rather brittle. H. 8·0; Gr. 3·5 to 4·9.

The red variety, when heated, becomes opaque and black, in cooling, green, then colourless, and lastly, red. Infusible before the blowpipe. Easily decomposed by fusion with bisulphate of potash. Insoluble in muriatic acid.

Composition: $\dot{\mathrm{M}}\mathrm{g}\,\dddot{\mathrm{A}}\mathrm{l}$; with alumina, 71·32; magnesia, 28·68; but part of the magnesia is usually replaced by some protoxides of iron, zinc, lime or magnesia, and the alumina by some peroxide of iron.

Spinel has been lately observed in the auriferous sands of mountain streams in Wicklow, in small rolled grains, by Mr. R. Mallet.

Class II. METALLIC MINERALS.

Order I. GOLD.

116. GOLD.

Cubic. Primary form the octahedron. British gold very seldom exhibits a definite form, but occasionally in Irish specimens portions of planes of the dodecahedron and the octahedron are visible.

Gr. 17 to 19; H. 2·5. Lustre metallic. Gold-yellow, the colour in Cornish specimens being usually dull. Fracture hackly, no trace of cleavage. Soluble only in nitro-muriatic acid; the solution, which is of a yellow colour, is more or less complete according to the quantity of silver or other substances the gold contains. On the addition of a solution of sulphate of the protoxide of iron, a reddish-brown precipitate of metallic gold is thrown down, which acquires metallic lustre by friction.

Au, with a variable quantity of silver, and traces of iron and copper. In our own country it usually occurs massive, dendritic, or in grains. It is soft, inelastic, flexible, and highly malleable, so much so, indeed, as to become translucent, as may be easily seen by laying gold-leaf between two films of mica or pieces of glass, and holding it close up to the eye. The colour thus transmitted is bluish-green.

The chief *localities* in this country are in Devonshire, at North Molton, where the works, originally carried on, it is supposed, by the Romans, have been recently resumed. At the Poltimore Copper and Gold Mining Company's establishment at North Molton, the red gossan gives an average yield, it would *appear*, of 1 oz. 7 dwts. to the ton, and the brown gossan 7 dwts. Also at Sheepstor, Dartmoor. In Cornwall at the Carnon Stream Works, Feock parish, and at similar works at Crow Hill. At Laddock, in grey quartz and in loose grains. In a cross-course at Wheal Sparnon; in gossan at Nangiles mine in Kea. The largest Cornish specimen yet found weighed 2 ozs. 3 dwts.

In several parts of North Wales gold occurs associated with galena, quartz, and blende. Merionethshire; on the hills a few miles from Dolgelly, at the Prince of Wales' mine; at Gogofan near Caio, in Carmarthenshire. Specimens of the Caio gold are preserved in the Museum of Economic Geology. In the time of the Romans a gold mine is said to have been worked at Gogofan in the neighbourhood of a place now called Pumpsant. In Merionethshire; at Cwm-eisian mine, with blende and quartz, but to no great extent; and at the Dolfrwynog mines.

Scotland.—Gold has been found in alluvial soil in the neighbourhood of Leadhills. In 1802, Dr. T. S. Trail discovered the only specimen yet met with in the matrix. It occurred near Wanlock Head, on the borders of Dumfriesshire and Lanarkshire. At Turrick in Glen Coich, near Amebrie, on the Breadalbane estate, a mass of gold weighing 2 ozs. 1 dwt. was found some thirty years since. It is now in Mr. Greg's collection. Gold has been observed by Mr. Tennant accompanying cubic pyrites near the Marquis of Breadalbane's shooting-box, nine miles south of Glencoe. In the reigns of James III., IV. and V. of Scotland, considerable quantities of gold in grains were found in that country, principally in Ettrick Forest, of which Leadhills is a part. During the reign of James V. the value of the gold from that district is said to have amounted to £200,000*.

Ireland.—Gold occurs at the base of the Croghan Kinshela Mountain in Wicklow; and in some of the streams in that district it is still sought for, though not to any extent, by washing the sand and gravel. Occasionally very fine specimens have been met with; one, indeed, occurred of the weight of 22 ozs., of which a model is to be seen in the collection at Trinity College, Dublin. Specimens of from 2 to 3 ozs. in weight have been found not very unfrequently. In the Trinity College Collection there is one preserved which weighs 815 grains.

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* The following is an extract taken from the 'Gentleman's Magazine' for June 1853:—"As to the various places in Scotland where gold has been found, reference may be made to the Otho MS. in the British Museum, to Atkinson's work, and to certain memoranda given to Mr. R. Sibbald by Mr. R. Seton and Colonel Borthwick. The auriferous district of Leadhills appears to be the largest in extent; for gold has been found, not only in all the streams which descend from the elevated plateau on which the village is situated, both into Dumfriesshire and Lanarkshire, but there are records of its discovery in various tributaries of the Clyde, from the source of that river, as low down its course as Biggar, embracing a district fully thirty miles in length by twenty in breadth. It has also been found in several of the upper tributaries of the Tweed, as at Kersop on Yarrow Water, near Philiphaugh; and in Glengaber Burn at Henderland in Ettrick, where the researches were most productive. It has also been discovered in Moffat Water, and other streams in Upper Annandale. In Aberdeenshire there are said to have been several gold mines at Dumdeer, Drumgavan, the bogs of New Leslie, and at Menzies, in the parish of Foveran. Rich deposits are also mentioned at Overhill in Behelvie, on the Strathmore property; and at Long Forghan Moor near Dundee."

Much has recently been said in reference to what have been rather pompously designated the "*Gold Fields* of Great Britain;" and much noise has been made as to considerable quantities of gold, chiefly in pyrites, quartz, and gossans, and also in nuggets, *said* to have been found in various parts of Wales, Derbyshire, and the lake districts of Westmoreland and Cumberland; but in the present work there is no occasion to endorse such questionable authority. It is a well-known fact, that much of the gold said to be now found at the Leadhills, and which commands a patriotically high price, is conveyed thither from Glasgow to be rediscovered at a home locality.

These Wicklow washings, though never permanently profitable, yielded at one time a comparatively large quantity of gold, the major part of which was wrought into articles of jewelry. The workings have, however, been suspended for many years, though, by the use of improved machinery, and, above all, under more economical management, they perhaps might be resumed, not, it is true, in the hope of reaping an inordinate profit from them, but as the means of affording available occupation to the peasantry. Gold was formerly obtained near the Kilkeel River in the heart of the Mourne Mountains, but the workings have long been flooded. Specimens from this locality are preserved in the Oxford Museum.

Iron pyrites and copper ores occasionally contain a little gold, and are then termed auriferous. A small quantity of gold is said to occur in the copper ores of the Goldscoop mine near Keswick.

Order II. SILVER.

117. **SILVER.**—Native Silver, *Phillips*; Argent natif, *Hauy*; Silber, *Haidinger*, *Naumann*.

Cubic. Primary form the cube. Fracture hackly. Lustre metallic, silver-white, but usually tarnished greyish or blackish. Ag; generally nearly pure. Malleable. Streak metallic. Cleavage none. H. 2 to 2·5; Gr. 10·3 to 10·5.

Readily soluble in nitric acid; on the addition of hydrochloric acid a precipitate of chloride of silver is produced, white at first, but on exposure to the light passing through bluish to black.

Silver usually occurs arborescent or filiform in veins of limestone, gneiss, or clay-slate.

Its principal British localities are in Cornwall, where it is met with usually in clay-slate. Formerly beautiful specimens were found, presenting a filiform appearance, at Wheal Vincent near Calstock, also at Wheal Herland and Wheal Basset: from each of the two last-mentioned mines £8000 worth of native silver is said to have been raised. It has also been found, occasionally in very fine specimens, at Wheal Mexico. At Dolcoath. At Wheal Duchy near Callington, associated with other ores of silver. At Wheal Anne and Wheal Alfred. At the Levant mine. At Wheal Tremayne in Gwinear, recently, in a capillary form, with galena. At Wheal Golden in Perranzabuloe, in greyish-white contorted threads of considerable thickness. In the same form at West Huel Darlington, Marazion, recently. At the Willsworthy mine on the borders of Devonshire, with arsenical cobalt and copper pyrites. At Lanescot and Wheal Brothers; and Crinnis mine. Lately in gossan, at Fowey Consols, St. Day*.

About the middle of the last century nearly £50,000 worth of silver was obtained at a mine at Alva on the Ochil Hills, in trap, in Stirlingshire, but it is no longer worked. Native silver was obtained nearly 300 years ago in the Hilderstone Hills in Linlithgowshire. It is stated to have occurred in a capillary form in veins traversing the blue limestone in the Isle of Isla. It has likewise been obtained in the Island of Mull.

Ireland.—Native silver occurs at Ballycorus, Co. Dublin.

Numerous as are the localities of native silver in Great Britain, the amount thus obtained is but inconsiderable compared with that which is extracted from argentiferous galena. At South Hooe mine, near Beeralston in Devonshire, galena has been met with which produced 135 ounces of silver to the ton. The Cornish, Devonshire, and some of the Welsh lead ores are the richest in silver; but it has been observed, with regard to the Welsh ores, that at a certain elevation above the sea the silver which they contain disappears almost entirely. In 1852 the yield of silver extracted from galena was 818,325 ounces, which, at five shillings an ounce, gives a value of

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* With galena, and vitreous silver, at an abandoned mine in Sark, one of the Channel Islands.

£204,581 (for details see Galena). In 1854 the amount fell to 562,000 ounces, worth £140,000.

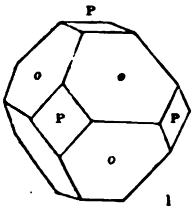
At Swansea, in South Wales, considerable quantities of pure silver are obtained by treating the copper slags and ores in a peculiar way; one firm was said to obtain from old copper slags half a ton of pure silver fortnightly.

An *arsenical silver* is stated by Mr. Garby to occur near Camborne. It is said to be found in concentric and lamellar concretions alternating with quartz. If it resembles the arsenical silver met with at the Samson mine in the Harz, it contains about 9 per cent. of silver, and its composition will have to be rendered by the following complicated formula:—

$$(FeS^2 + FeAs) + 5(5\,Fe^4As^3 + Ag^2Sb^3).$$

118. ARGENTITE.—Vitreous Silver, *Phillips*; Argentit, *Haidinger*.

Cubic. Hardly a trace of cleavage. Fracture uneven, flat, conchoidal. Lustre metallic. Blackish, lead-grey. Streak shining. Perfectly malleable; very sectile, may be cut like lead. H. 2·5; Gr. 6·9 to 7·2.



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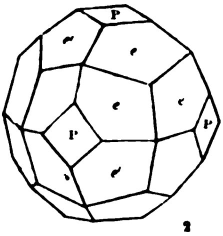


2

P P	90° 00′
P *o*	125 16
P *n*	144 44
o o	109 28
n n	146 27

Combinations: P *o*; P *n*.

With blowpipe upon charcoal fuses readily with intumescence, giving off the odour of sulphurous acid. Easily soluble in concentrated nitric acid, with separation of sulphur.

Composition: $\acute{A}g$; with		
	Silver	87·05
	Sulphur	12·95
		100·00

This is a scarce species in Great Britain, and its occurrence in crystals has been of late years noticed only in a few Cornish mines. It occurs also compact, investing other minerals, and pulverulent, and when earthy is quite black, in which condition it is known as black sulphuret of silver.

It has been found lately in a north and south lode traversing the Dolcoath mine, Camborne. Recently also at Mexico mine, and in an earthy form at Wheal Duchy. Formerly at Wheals Vincent and Brothers near Calstock, and at Wheal Basset near Redruth. It occurred also formerly, distinctly crystallized and massive, at Wheal Herland in Gwinear, where small and well-defined crystals have again been recently found. Figure 1 is copied from a recent Herland specimen. Wheal Ann in Gwinear, has also furnished specimens.

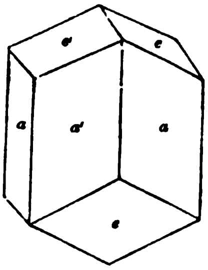
With galena in the silver-mine, no longer worked, in the Island of Sark.

Many years since at Alva in Stirlingshire, with native silver and cobalt-bloom.

119. PYRARGYRITE, *Haidinger*; Dark-red Silver, *Phillips*.

Rhombohedral. Cleavage tolerably distinct parallel to the sides of a rhombohedron of 108° 42′. The crystals not unfrequently differently modified at their opposite extremities. Fracture conchoidal, uneven. Transparent on the edges. Lustre metallic, also adamantine. Cochineal-red, blackish lead-grey. Streak cochineal-red. H. 2·5. Slightly sectile. Gr. 5·72 to 5·84.

Decrepitates before the blowpipe. Fusibility, 1. By long exposure to the flame on charcoal it is reduced, abundant antimonial fumes being given off. In a solution of caustic potash the powder becomes black, and sulphide of antimony is extracted.



e e' 137° 58'
a a' 120 00

Composition :—

	Silver	58·98
$\acute{A}g^3\overset{'''}{Sb}$	Antimony	23·46
	Sulphur	17·56
		100·00

As a British species it is almost confined to Cornwall, where it cannot be said to be rare, though it does not occur in sufficient abundance to be of much commercial value. It has been met with in tolerable quantity in Huel Brothers; also in a cross-course at Wheal Duchy, near Callington, both crystallized and massive. Formerly at Herland mine in small crystals and granular, and again recently at the same locality. At Perran mine in the Peru lode.

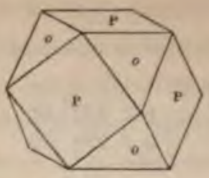
A few crystals were met with at the silver-mine in Sark.

The name pyrargyrite is derived from πῦρ, *fire*, and ἄργυρος, *silver*.

120. KERATE, *Haidinger*; Horn-silver.

Cubic. Primary form the cube. Fracture flat, conchoidal. Cleavage none. Lustre greasy, adamantine. Pearl-grey or greenish. Streak white, shining. Sectile. Translucent. H. 1·2; Gr. 5·5 to 5·6.

Easily reduced. Fused on charcoal with oxide of copper it imparts a beautiful blue colour to the flame. Slightly attacked by nitric acid. Partially soluble in caustic ammonia.



P P	90°	00′
P *o*	125	15
o o	109	28

Combinations: P; P *o*.

AgCl	Silver	75·34
	Chlorine	24·66
		100·00

Has been found crystallized, massive, and investing other minerals at some of the Cornish mines and at a few other localities, but it is a rare British mineral. It occurred crystallized in small cubes, and in cubic dodecahedrons, in brown gossan at Wheal Duchy in Phillack, and associated with native silver at Wheal St. Vincent, both near Calstock; also at Huel Mexico in Perranzabuloe, crystallized and massive. At Silver Valley and Wheal Brothers.

At the Sark silver-mine it formerly occurred massive, and disseminated in gossan in considerable quantities.

In Ireland it is reported as accompanying native silver, at Ballycorus, Co. Dublin.

Order III. PLATINUM.

121. PLATINUM.—Native Platina.

Cubic. Primary form the cube. No cleavage. Fracture hackly. Opaque. Lustre metallic. Steel-grey, streak the same, shining. Ductile and malleable. H. 4·5; Gr. 17·5 to 19·0.

Frequently magnetic. Before the blowpipe, alone or with fluxes, unchangeable. Soluble only in nitromuriatic acid. The solution yields a yellow precipitate on the addition of a salt of potash. Platinum, as it occurs in nature, always contains from 14 to 26 per cent. of other metals, iron being always one, and varying in amount from 5 to 16 per cent.; the other metals are iridium, osmium, rhodium, palladium, ruthenium and copper.

Seldom found crystallized; usually in small irregular masses or grains.

In this country has been recently observed by Mr. W. Mallet, of Dublin, in minute grains and scales in the auriferous sands of some of the Wicklow rivers, associated with gold, wood-tin, spinel, &c.

A few grains were found in sinking a well at Fort Regent, in Jersey, according to Mr. H. Campbell White.

It is said to have been lately found on a farm near the mouth of the river Urr, in the parish of Buittle, Kirkcudbrightshire.

Order IV. IRON.

122. IRON.—Native Iron. Meteoric Iron.

Octahedral. Fracture hackly. Surface rough. Granular. Opaque. Steel-grey. Malleable and ductile. Affects the magnetic needle very strongly. H. 4·5; Gr. 7 to 7·8.

Fusible with great difficulty before the blowpipe. Readily soluble in hydrochloric acid. Sometimes crystallizes in octahedrons after fusion.

Iron of terrestrial origin is almost chemically pure, and nickel has not been observed in it.

Dr. Andrews has lately shown that minute but appreciable particles of native iron are present in most of the basaltic rocks of Antrim, especially in the green basalt of Slieve Mish.

Meteoric iron always contains nickel, and usually cobalt and traces of other metals.

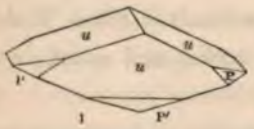
Only one specimen of meteoric iron is known to have been found in Great Britain. It is a small angular and rounded mass with a closely crystalline texture, is extremely hard, and where cut and polished shows numerous small triangular figures, more brilliant than the rest of the surface, as in most meteoric irons. It was found a good many years back by Da Costa at Leadhills, and is now in Mr. Greg's collection.

List of British Meteoric Stones, with date of Fall.

1.	10th January,	1622, in Devonshire.
2.	9th August,	1628, at Hatfield, in Berkshire.
3.	4th August,	1642, near Woodbridge, Co. Suffolk.
4.	?	1676, in the Orkneys.
5.	18th May,	1680, near London.
6.	3rd July,	1725, at Mixburg, Northamptonshire.
7.	?	1779, at Pettiswood, Co. West Meath, Ireland.
8.	1st April,	1780, at Beeston.
9.	?	1791, at Menabilly, Cornwall.
10.	13th December,	1795, at Wold Cottage, Yorkshire.
11.	October,	1802, in Scotland.
12.	4th July,	1803, at East Norton, in Leicestershire.
13.	5th April,	1804, at High Possil, near Glasgow.
14.	17th May,	1806, at Basingstokes, Hants.
15.	August.	1810, at Mooresfoot, Tipperary.
16.	10th September,	1813, at Adare, Co. Limerick.
17.	15th February,	1830, at Launton, near Bicester, Oxfordshire.
18.	4th August,	1835, at Aldsworth, near Cirencester.
19.	29th April,	1844, at Killeter, near Castle Derg, Co. Tyrone.
20.	?	? at Pulrose, Isle of Man.

123. SPECULAR IRON.—Hematite. Red Iron-ore. Hämatit.

Rhombohedral. Cleavage more or less distinct parallel to P, occasionally hardly perceptible; there is also a cleavage to be obtained parallel to the base, but this is probably rather a plane of union, according to Professor Naumann.



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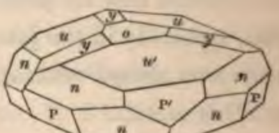


2

P P′	93° 50′		*y y*	160° 48′		*y o*	168° 54′
n n	128 04		P *o*	122 30		*n o*	118 53
u u	143 07		*u o*	158 35		P *n*	154 02

Combinations: *u*; *u o*; *u o* P; *u* P; *u o* P *n y*.

Fracture conchoidal to uneven. Brittle. H. 5·5 to 6·5; Gr. 5·19 to 5·23.

Iron-black to dark steel-grey, often iridescent. Streak cherry-red, brownish-red, to reddish-brown. Lustre metallic, opaque, except in very thin laminæ, which are translucent and blood-red by transmitted light. Rarely feebly magnetic.

Before the blowpipe in the reducing flame it becomes black and magnetic, and behaves like oxide of iron with borax and salt of phosphorus. Only very slowly soluble in acids.

$\ddot{F}e$	Iron	70
	Oxygen	30
		100

with an admixture occasionally of titanic acid, oxide of chrome, or silica.

This species comprises the old species, specular iron and red iron ore; the latter is usually uncrystallized, though it occurs sometimes in the form of scales, which are of the colour that the former presents when it is reduced to powder.

Specular iron includes varieties with a perfect metallic lustre, and is generally crystallized. If the structure is scaly, as is often the case, it is termed micaceous iron.

Localities.—*England.* Cornwall; specular iron occurs in Tincroft near Pool, and at various mines near Carn Brae, either massive or micaceous. At Wheal Maudlin near Lostwithiel. Micaceous at Wheal Beauchamp near Redruth. At Boscaswell Downs, St. Just. At Huels Billon and Maggot. At Botallack with Arragonite, and formerly in small nail-headed crystals of the form of figure 1, being very obtuse rhombs; the faces *u* smooth, curved, and of a steel-grey colour. The crystals are implanted on crystals of quartz, and present the forms *u*; *u o*; *u o* P; *u* P. At Parknoweth, Huel Owles, and at Carnyworth, all near St. Just: at the latter mine in flat rhomboids.

Devon; at Hennock.

Gloucestershire; near Bristol in lias.

Lancashire; near Ulverston, in fine and brilliant flat crystals, figure 2, on hematite, associated with good pyramidal crystals of smoky quartz.

Cumberland; near Keswick, and micaceous at Eskdale. At Cleator Moor near Whitehaven.

Scotland.—In greenstone at Salisbury Craig, near Edinburgh. At Dunkeld and Ben More, Perthshire. At Cumberhead in Lanarkshire. At Fitful Head, Sandlodge; and crystallized at Hilleswick, in Mainland, Shetlands. Micaceous in clay-slate, Isle of Bute.

Ireland.—At Coosheen near Skull. In small steel-coloured six-sided crystals, tarnished, in fissures in greenstone, with stilbite, at Bennevenagh. At the Carrick Hills, Derry; at Tullybrick in Ballynascreen. In small crystallized red plates in rock-crystals at Kerry Head, Kerry. In clay-slate in the Island of Magee, Co. Antrim.

Red Hematite occurs in Devon at Hennock. Cornwall; in largish reniform masses at Ladock iron-mine, near Grampound, at Wheal Rave near Helston, and at the Levant mine near St. Just. Gloucestershire; at Clifton, and in the Forest of Dean. Lancashire; at several places near Ulverston, among which may be cited Lindel Moor, Staunton, Furness and Silverstein, at all of which it is found in very large kidney-shaped masses formed of concentric and fibrous coats, presenting externally the appearance of having been hammered. In Cumberland; at Cleator Moor. Scotland; in Ayrshire. In Ireland; at Ballintory.

Red Iron Froth.—At Tincroft, Illogan; and at Carn Brae in the same parish. At St. Just; in Levant mine, Cornwall. In Lancashire; at Ulverston.

Jaspery Iron-ore.—In Cornwall; at Botallack, St. Just, of a yellowish-brown colour, and having a flat conchoidal fracture. In Shropshire; at Billingsley. At Clifton, Gloucestershire.

Red Iron Ochre occurs abundantly in the parish of Davidstow, near Camelford in Cornwall, at Great Chew near Wrenton, Somerset; of a brilliant red, occasionally, at Ulverston.

Reddle, or *red iron chalk*, occurs at Wastwater, Cumberland; it has an earthy texture and conchoidal fracture.

Red iron-ore has sometimes a columnar or flat granular fracture.

Pseudomorphous crystals of specular iron have been met with in the western part of Cornwall in the form of calc-spar, and at Ulverston in orbicular crystallized masses, having the form and structure of cockscomb barytes.

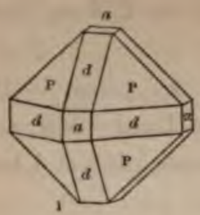
This species of iron-ore is of much value to the smelter, but is so refractory, especially the specular variety, that it requires to be mixed with clay iron-ore to render it more readily fusible.

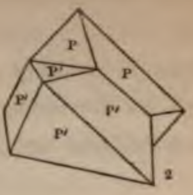
The Ulverston district, Cleator Moor and the Forest of Dean, are the principal places where this ore is worked.

124. MAGNETITE.—Magnetic Iron-ore.

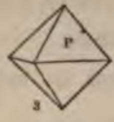
Cubic. Octahedral. Cleavage parallel to *o* (but varying considerably in distinctness) and also to *a*; the faces *d* usually striated parallel to their intersections with *o*. Fracture conchoidal to uneven. Brittle. Lustre metallic, sometimes imperfectly so. Opaque. Iron-black. Streak black, very strongly magnetic, especially the massive. Exhibits polarity. H. 5·5 to 6·5; Gr. 4·9 to 5·2.

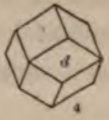
Occurs crystallized, lamellar, granular, compact and earthy. Sometimes forms beds and large irregular masses. Most common in primitive districts. In imbedded crystals, and disseminated in chlorite-slate, serpentine, granite, basalt, limestone, syenite, &c.





P P	109° 28′
a a	90 00
P *a*	125 16
d d	120 00
P *d*	134 44
a d	135 00





Combinations: P; P*d*; P*d a*; twins of P.

Before the blowpipe it is fusible with great difficulty; with borax and salt of phosphorus gives the reactions of iron; in powder completely soluble in hydrochloric acid.

Peroxide of iron . . .	68·97
Protoxide of iron . . .	31·03
	100·00

$\dot{F}e\dddot{F}e$; equal to 72·4 iron, and 27·6 oxygen.

Localities.—*England.* Cornwall; magnetite occurs crystallized at Wheal Harmony near Redruth. It is found also at some of the St. Agnes mines, in the parishes of Roach and St. Stephens, and at Treluswell near Penryn.

Devon; at Haytor with felspar and hornblende, and near Tavistock.

Scotland.—At Portsoy in Banffshire. In the Shetlands there are many good localities, among which may be cited Unst, where octahedral crystals an inch in diameter occur. In chlorite, at Carnebie, in small octahedrons, and at Odsta, north-west point of Fetlar. At Saxford Hill in large quantity, and at Kleber Gio, peninsula of Fiedland. In East Rona, one of the Hebrides, in twin octahedrons (in granite), figure 4. In the Island of Isla, in white limestone with hematite. At Lossit Hill, in small crystals. In the Isle of Bute. Near Loch Long, &c.

Ireland.—Crystallized in the form of figures 1, 2 and 3, in small perfect crystals, in amygdaloid, at Muck and Magee Islands, Antrim.

Magnetic iron sand is found at Hunstanton in Norfolk, and also in the beds of several rivers, for instance, in the Mersey near Seacomb Ferry, Cheshire; in Aberdeenshire, in the Dee and the Don; and in Ireland, in some of the Wicklow rivers near Crogan, Kinshela and Carysfoot Mountains. In the schist rocks of the Mourne Mountains there is found a variety of crystalline magnetite whose composition differs slightly from that represented by the formula given above. Its constituents are, according to Dr. Andrews of Belfast,—

	Peroxide of iron . . .	71·74
$(\dot{\mathrm{Fe}}\dot{\mathrm{Mg}})\dddot{\mathrm{Fe}}$	Protoxide of iron . . .	21·59
	Magnesia	6·45
		99·78

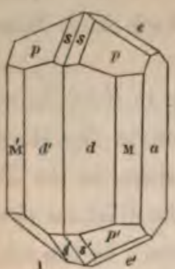
the magnesia replacing a portion of the protoxide of iron.

The large octahedral crystals from Muck Island, Antrim, contain also, according to Dr. Andrews, 2·00 magnesia, and 0·23 oxide of manganese.

125. GÖTHITE.—Hydrous Oxide of Iron.

Prismatic. Primary form a right rhombic prism. Cleavage perfect parallel to *a*. Brittle. H. 5 to 5·5; Gr. 3·8 to 4·2.

Yorke states the Gr. of the crystals from Lostwithiel to be 4·37. Yellowish-brown, reddish-brown to blackish-brown. Streak bright yellowish-brown, usually translucent on the edges to opaque, in thin plates and fine needles hyacinth-red by transmitted light. Lustre adamantine, silky. The face *e* smooth; *d k* M striated vertically; *p* sometimes rather uneven; *a* often enlarged, giving the crystals the appearance of thin plates.



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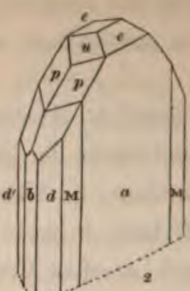

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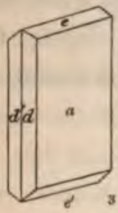

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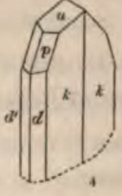

4

r b 149° 28′		*p p* 126° 18′	
r a	106 00	*p p′*	83 47
r r′	128 32	*s s*	151 35

M M′	94° 52′
d d′	130 40
k k	144 00
a b	90 00
k a	162 00
l a	151 42
M *a*	132 34
d a	114 40
e a	121 12
u u′	113 06
e e′	62 30
e e	117 30
b u	123 27
p a	116 51
s a	104 13
u a	90 00
e b	90 00
p b	119 28
s d	126 05
z a	141 42
z b	109 59

British forms: *ade*; *adp*; *ad*M*p*; *d*M*ps*; *d*M*p*; *d*M*pb*; *ad*M*ps*; *ad*M*pe*; *ad*M*peur*; *ad*M*pes*; *ad*M*peslz*; *adeu*; *adep*; *adeup*; *abdeup**. The face *r* truncates the edge M *a*; *z* the edge *pa*; *u* the edge *ss*: *k* not before described.

In the closed tube disengages water and becomes red. Before the blowpipe assumes a reddish-brown colour in the oxidating flame, but in the reducing flame becomes black, and magnetic; very difficultly fusible; with borax and salt of phosphorus gives the reactions of iron, in hydrochloric acid easily and perfectly soluble, often leaving a slight residue of silica.

Crystals from Lostwithiel, analysed by Mr. Yorke, afforded,—

Peroxide of iron	89·5
Water	10·1
Manganese and silica	0·4
	100·00

$\dddot{\text{F}}\text{e}\dot{\text{H}}$; with peroxide of iron, 89·89; water, 10·11.

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* Also, *abd*M*peur*; *abd*M*pseuz*, according to Brooke and Miller.

It occurs likewise in reniform masses with a fibrous structure and velvety surface, in capillary and scaly crystals, in tufts, compact, granular, and columnar; also in pseudomorphous forms after pyrites.

LOCALITIES.—*England.* The finest and most perfect crystals hitherto found, occur in quartz at Restormel iron-mine near Lostwithiel in Cornwall; one of them is given in figure 1. They are often doubly terminated, and very brilliant. Crystals resembling figure 4 are met with also at the same locality penetrating quartz crystals in geodes. The following combinations have likewise been observed from the same mine: *adp*; *ad*M*p*; *d*M*ps*; *d*M*p*; *ad*M*peur*; *d*M*pb*; *ad*M*pe*; *ad*M*ps*; *ad*M*pes*; *ad*M*peslz*.

Crystals showing the combination *ad*M*ps*, have recently occurred at Botallack near St. Just, where it is also met with in fibro-crystalline specimens. In translucent plates, of a hyacinth-red colour, and in scales, at Carn Brae and Huel Beauchamp, both near Redruth. Fibro-crystalline at Tincroft, Illogan. The form given in figure 4 presents a new form *k*, not before described, from Cornwall.

Gloucestershire; near Clifton, now and then abundantly, in geodes, presenting beautiful diverging tufts resembling the Russian variety termed Onegite and *flèches d'amour*, and with the form, generally speaking, *adp*, in needle-shaped crystals, locally termed *lances*.

Somersetshire; at the Providence iron-mines, crossing the Avon at the ferry at the Hot Wells, and about three-quarters of a mile from the river, up the road to the left, they are found in still greater perfection, associated with the finest amethystine quartz met with in England. From these localities the forms shown in figures 2 and 3 have been observed, and likewise the combinations *adp*; *abdeup*; *adeu*; *adep*; and *adeup*.

Scotland.—In nodules of trap-rock at Gourock in Renfrewshire. Dr. Heddle has met with crystallized specimens at Burn in the Sail, Hoy, Orkneys. Also in translucent scales (*rubinglimmer*) of a hyacinth-red colour at Kilpatrick, with zeolite.

Note.—The Restormel Göthite is one of the substances on which some dealers in minerals in the West of England exercise their ingenuity, by selling as rutile specimens of this species which they have exposed to a strong heat. The deception may be readily discovered by observing the difference of form in the two substances, or by crushing a small fragment of the mineral upon a slip of white paper, upon which the roasted Göthite leaves a strong yellowish-brown streak, while rutile does not do so. Very fine crystals have occurred very recently at the Restormel iron-mine, some being $1\frac{1}{2}$ to 2 inches in length and $\frac{3}{8}$ths of an inch across; but these very large crystals are not so brilliant as the smaller ones. Also penetrating quartz crystals, at the Delabole slate quarries near Camelford.

126. LIMNITE.—Brown Hematite. Limonit, *Haidinger*. Wood Iron-ore.

Opaque. Lustre imperfect, silky, glistening, and dull. Clove-brown to yellowish-brown and ochre-yellow on the one hand, and ranging to blackish-brown on the other. Streak yellowish-brown to ochre-yellow. H. 5·0 to 5·5; Gr. 3·4 to 3·95.

In the closed tube yields water. Before the blowpipe in the oxidating flame becomes brownish-red, but in the reducing flame black and magnetic; gives with salt of phosphorus or borax the reaction of iron, easily and perfectly soluble in hydrochloric acid, leaving frequently a slight residue of silica.

Analysis, by Yorke, of a Cornish specimen :—

Peroxide of iron	82·16
Phosphoric acid	1·13
Water	14·28
Silica	2·42
	99·99

$\dddot{\bar{F}}^2\dot{\bar{H}}^3$; with peroxide of iron, 85·6; water, 14·4.

Has only been found in fine fibres united into globular, reniform, and stalactitic aggregations having a radiating fibrous or curved lamellar structure, the surface presenting various degrees of lustre; compact and earthy; pseudomorphous after calcite and pyrites. It occurs both in crystalline and in secondary rocks, in beds and veins, often associated with siderite, barytes, calcite, quartz, and very frequently with ores of manganese.

Localities.—Cornwall; at Botallack and other mines near St. Just; at Tincroft and Carn Brae in Illogan; near Ladock, and at various mines near St. Austell. At Restormel near Lostwithiel. In pseudomorphs, after cubic pyrites, at South Basset mine, also after calc-spar, perhaps from the same locality. Rounded masses from near Lostwithiel, often very prettily marked, are not unfrequently offered for sale as wood-tin. In very fine crystals, 1 to 2 inches in length, with the form of Göthite, lately, at the Restormel Royal Iron-mines, Lostwithiel.

At the Brendon Hills, Somerset, in grauwacke and slate, a locality known to the Britons.

Gloucestershire; at several places near Clifton, as at Wrington Hill.

Plentifully near Weardale, Durham.

Cumberland; in the neighbourhood of Alston, abundantly, and likewise of a black colour, at Carrock Fell.

Manghold Head, Isle of Man.

At Leadhills and Cumber Head in Lanarkshire. At Salisbury Craig near Edinburgh, fibrous and diverging with calcite in greenstone. At Lossit Hill in the Island of Isla. At Burn of the Sail, Orkneys; and at Hoy Head, coating psilomelane, in fine glossy black specimens, as also *pseudomorphous* after pyrites, with the forms of the cube and pentagonal dodecahedron, according to Dr. Heddle, and after marcasite, near Stromness. At Sandlodge copper-mine, Mainland, Shetlands; and massive at Largebaun Caves in the Mull of Cantyre.

Stilpnosiderite.—This variety is found, Mr. Garby states, at Tincroft, Illogan, Cornwall, in botryoidal groups of a dark-brown colour, and presenting occasionally tarnished colours. There is some doubt whether this variety is properly included under the head of limnite, for while, according to Ullmann, it is identical with limnite in chemical composition, the researches of von Kobell attribute to it the constitution of Göthite.

Wood Hematite has lately occurred in very fine specimens at the Royal Iron-mines, Lostwithiel, Cornwall.

Earthy Hematite occurs in several of the Gwennap mines; at Sandlodge copper-mine, Mainland, Shetlands; at Bardahessiagh near Pomeroy, Co. Tyrone; under the trap at Craignashoke and Donald's Hill in Ulster.

Bog Iron-ore is of recent formation, arising from the decomposition of rocks over which water runs. It is common in the peat-bogs of Ireland and of the Shetlands. From the nature of its origin, it of course differs materially in its composition, so much so, that the quantity of peroxide of iron which it contains varies from 20 to 78 *per cent.*; it usually contains, also, protoxide of iron and oxide of manganese; from 7 to 30 *per cent.* of water; from a mere trace to as much as 9 or 10 per cent. of phosphoric and organic acids, with almost always silica, sometimes in very considerable quantity, in a state of chemical combination. When it occurs in small globular concretions it is termed *Pea iron-ore.* Deposits of this nature are met with in the Isle of Anglesey; at Tremadoc in Carnarvonshire; at Galston in Ayrshire; and at Clonmore in Mayo.

Brown Iron-stone is plentiful in the greensand of Sussex, as in the neighbourhood of Battle. At Colebrook Dale. Shropshire.

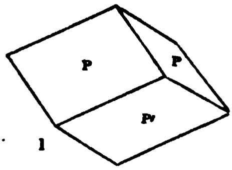
Yellow Iron Ochre is so widely diffused, that the mention of one locality will suffice, namely, at Pary's mine in Anglesey, where considerable quantities have been raised to be used as paint.

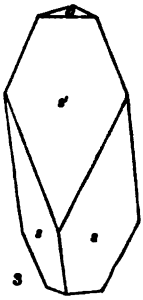
Hematitic Conglomerates are a valuble ore of iron, though frequently impure; they occur in regular beds of considerable extent at Neweant in Gloucestershire; Brockwell in Somerset, and at Cowbridge in South Wales; and usually at the base of the new red sandstone series.

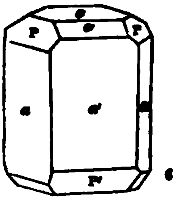
This species, in one form or another, is common in Great Britain, and the iron obtained from it is, for the most part, of excellent quality. That which is procured from bog-iron ore and pea-iron ore, is, however, so brittle, owing to the presence of the phosphoric acid, which so frequently is met with in those ores, that for many purposes it is almost valueless.

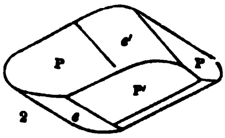
127. SIDERITE.—Spathose Iron. Carbonate of Iron. Chalybit, *Glocker*. Brown-spar. Sphærosiderite. Junkerite, *Dufrénoy*.

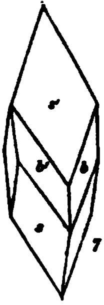
Rhombohedral. Cleavage perfect parallel to P; *e*, traces. The faces *e* often striated parallel to their intersections with P; P, *e* frequently curved; *b* smooth, *m* uneven; *s* frequently uneven or curved. Twin-faces *e*, *o*. Fracture imperfect conchoidal. Frequently massive, in coarse and fine granular aggregations; rarely, in botryoidal or reniform masses, to which the name *Sphærosiderite* has been given; also in massive and fine granular varieties, containing an admixture of clay, which occur occasionally in round or elliptic nodules, and are frequently deposited in continuous beds. These varieties are termed *Clay iron-ore*. Yellowish-grey to pea-yellow, and yellowish-brown, red. Lustre vitreous to pearly, translucent; when decomposed, blackish-brown, dull, and opaque. H. 3·5 to 4·5; Gr. 3·7 to 3·9.

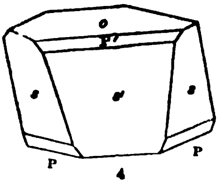


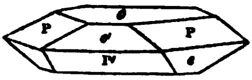












e e	136° 34′	*o u*	163° 00′	*o s*	101° 57′	*v* P	150° 45′
P P	107 00	*o e*	154 43	*o a*	90 00	*v v*	144 56
f f	80 06	*o* P	136 37	*a a′*	120 00	*v v′*	105 15
m m	66 18	*o f*	117 53	*b a*	150 00	*v v″*	134 40
s s	64 10	*o m*	104 49	*b b′*	120 00	*v o*	121 25

Combinations: P; *f*; *s*; *f a*; *a o*; P *o*; P *a o*; *s o*; *m o*; P *m f*; P *e*; P *o e*; P *o u*; P *o s*; P *o s e*; P *a o s e*; P *a o e*; P *s b*; *s b*; *v*; P *v*; P *v b*; P *a o f e*. All these forms have been observed in Cornwall and Devon.

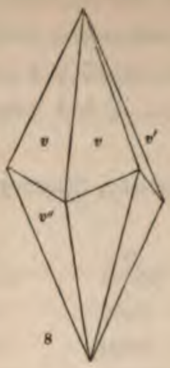
Before the blowpipe infusible, but becomes black and magnetic. With borax and salt of phosphorus it gives the reactions of iron, and with soda generally affords indications of manganese. In powder soluble with effervescence in acids, but not readily unless heat is applied. It is essentially a carbonate of protoxide of iron, but hardly ever pure, containing almost always carbonate of manganese or of magnesia, or both, sometimes as much as 10 or 15 per cent. Lime is also not unfrequently contained in it, but usually in less quantity.

Analyses: *a*, of a foreign fibrous variety, Stromeyer: *b*, from Durham, by Thomson:—

	a.	*b*.
Protoxide of iron . . .	59·63	54·57
Protoxide of manganese .	1·89	1·15
Lime	0·20	3·18
Carbonic acid	38·04	35·90
	99·76	94·80

$\text{Fe}\ddot{\text{C}}$; with protoxide of iron, 62·07 : carbonic acid, 37·93.

Occurs crystallized both in simple and compound crystals; also fibrous, in aggregated lenticular or globular forms, and massive. Many years since, a singular variety in large crystals, with the forms of figures 5 and 6, was found lining the interior of a large geode at Wheal Maudlin near Lostwithiel; the terminal face *o* is beautifully marked in brown and yellow concentric delineations: the greater part of this geode is now in the possession of Mr. Lavin of Penzance. Crystals with the form of figure 6 occurred also at Wheal Maudlin. It has likewise been met with in six-sided prisms at Huel Boulton. At the Charlestown United mines, St. Austell, crystals occur equally remarkable for the perfection of their form and the beauty of their iridescence. Very perfect crystals occurred formerly at Crinnis mine near St. Austell, studded with small crystals of Childrenite. *Lately*, at Fowey Consols, with the form of figure 9, and much resembling octahedral crystals of fluor-spar; and at Bucker's mine, near St. Austell, in small brilliant crystals, figure 8, presenting the form *métastatique* of calc-spar; also P *v* and P *v b*: these interesting forms were noticed by Mr. Talling of Lostwithiel.



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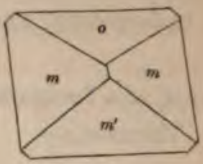

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Localities.—In various forms and very fine crystals at Carnyworth, and in acute rhomboids at Huel Owles, both near St. Just. At Fowey Consols, Tywardreath, recently, in acute rhomboids like figure 3, of a rich brown colour and translucent, the faces slightly curved. At Rocks and Treverbyn United mines near St. Austell, and at Lopez mine in fine iridescent crystals. Botallack, St. Just, in very fine obtuse, brown rhomboids. Pseudomorphous in the form of fluor at Wheal Maudlin. Lately, with the form P *a o e f*, in very fine detached hexagonal crystals upwards of an inch in length, attached to quartz crystals, near Bodmin, and noticed by Mr. Talling.

Devonshire; at Virtuous Lady mine, now Bedford United mines, near Tavistock, lately, in fine spheroidal groups made up of curved tabular crystals of a rich hair-brown colour. *Pseudomorphs*, in the form of calcite, at Beeralston; at the same mine occur large flat hollow crystals, probably after selenite, locally called *slippers*; these crystals are met with also in inferior specimens at Wheal Friendship. At Virtuous Lady mine are likewise found hollow cubes of siderite, from a small size to 3 or 4 four inches square; in the interior of the cubes there are not unfrequently a few splendid tetrahedral crystals of copper pyrites, remarkable for the beauty of their tarnish and for the manner in which they are traversed with diverging groups of opaque-white, radiating groups of quartz crystals. The original cubic crystals on which the siderite has been deposited, may probably in most cases have been pyrites, which is very abundant in that form at this locality, but the authors know of one instance in which this spathose covering completely invests a cube of fluor.

In the British Museum there is a very fine specimen of these curious hollow cubes, which are known to the miners by the name of *boxes*. Many fine and interesting crystallizations of this mineral have occurred at the Virtuous Lady mine. In beautiful crystals on quartz at Ivy Bridge Consols. In lenticular crystals at Beeralston. *Pseudomorphous* at Wheal Crebor near Tavistock.

In simple rhombs, on quartz, at Goginan mine, Cardiganshire, in Wales.

Fibrous; at Cook's Kitchen, and at several mines near St. Austell; at Tincroft, Illogan; and at Wheals Buller and Beauchamp, Redruth.

At Rowsay, Orkney, massive, interstratified with, and impregnating the sandstone cliffs. With hematite at the Mull of Cantyre.

Massive, occasionally at Alston, Nenthead, Allendale, Teesdale. At the railway-cutting, Plympton, Devon, of a beautiful white.

Columnar, in the Island of Arran.

The variety called *sphærosiderite* has occurred at Madron near Penzance; and lately at Mount mine, externally resembling calamine.

Clay Iron-stone, or massive siderite, with an admixture of clay, in its bituminous variety the *black band*, is the most valuable ore of iron, from its occurring so abundantly in the coal formations of Staffordshire, South Wales, and Lanarkshire; also, lately, in Northamptonshire.

It is met with of excellent quality in Ireland, as at Arigna in Roscommon, and at Clonmore, Ireland.

The production of pig-iron in the United Kingdom, in 1855, reached nearly 3¼ million tons. In 1851 the production was also about 2,500,000 tons, of which more than 2,000,000 were produced from the clay iron-stone.

Considerable quantities of spathose, or the crystalline carbonate, are now raised at Brendon Hill in the N.W. of Somerset, and sent to Monmouthshire for smelting: this variety is now found to make the best steel.

In 1855, the total quantity of iron-ore raised in the United Kingdom was about 9½ millions of tons (see Appendix, No. 1).

128. ILMENITE, *Kupffer*. Titaniferous Iron. Menacconite. Hystatite. Washingtonite, *Sheppard*; Crichtonite, *Haidinger*.

Rhombohedral. Fracture conchoidal. Opaque. Lustre metallic, imperfect. Colour, iron-black passing into steel-grey. Slightly influences the magnetic needle. Brittle. H. 5·0 to 6·0; Gr. 4·5 to 5·3.

Infusible before the blowpipe. With salt of phosphorus in the inner flame forms a dull red glass. Imparts a blue colour to concentrated sulphuric acid, without dissolving. In fine powder soluble in strong muriatic acid. The concentrated solution will after a time yield a precipitate of titanic acid, after having been largely diluted and boiled with water.

The analyses of this mineral vary considerably in the relative proportions of iron and titanic acid: *a* (Ilmenite), by Mosander; *b* (Washingtonite), by Marignac; *c*, from Egersund, by Kobell; *d*, from Egersund, by Mosander; *e* (hystatite), from Arendal, by Mosander:—

	a.	*b.*	*c.*	*d.*	*e.*
Titanic acid . . .	46·92	22·21	43·24	41·08	24·19
Red oxide of iron .	10·74	59·07	28·66	25·93	53·01
Protoxide of iron .	37·86	18·72	27·21	29·04	19·91
Protox. manganese	2·73	...	...	...	...
Lime	...	...	...	0·49	0·33
Magnesia . . .	1·14	...	...	1·94	0·68
Silica	...	...	...	0·07	1·17
	99·39	100·00	99·11	98·55	99·29

$\ddot{\text{Ti}}$ and $\overset{\cdots}{\text{Fe}}$, in various proportions.

Occurs in attached and imbedded crystals, though rarely; generally in granular and lamellar masses; also disseminated in grains more or less angular; when found in the form of iron-sand, it is sometimes called *iserine*.

Localities.—*England.* The variety formerly known as *Menacconite*, is found in grains, and small angular fragments of an iron-black colour, mixed with sand, in the bed of a rivulet at Tregonwell Mill, near Menaccan, in the parish of St. Keverne near Helstone, in Cornwall; in a stream at Lanarth in the same parish; another variety occurs in a diallage rock near Gwendra on the southern coast of Cornwall.

Titanic iron, or *Ilmenite*, has been lately found in crystalline lamellar masses by Dr. Heddle, at Glen Finnart in Argyleshire, in mica-slate with chlorite. Similarly on Ben Ima, and at Hillswickness in Shetland.

Ireland.—By Mr. H. W. Ormerod of Manchester, in flat crystalline masses, like the *Washingtonite* of Sheppard, engaged in quartz, and of a steel-grey colour, at Breaghy Head, S.E. of Sheephaven Bay, Co. Donegal. In lamellar crystalline masses, also, at Ballinascreen, Co. Derry.

129. ISERINE, *Phillips*; Titaneisenstein, *Hausmann*; Iserin, *Haidinger*; Hexaedrisches Eisen-Erz, *Mohs*.

Cubic. The faces of the crystals uneven, rounded. No cleavage observable. Fracture conchoidal. Opaque. Lustre metallic, imperfect. Iron-black. Brittle. Highly magnetic. H. 6·0 to 6·5; Gr. 4·86 to 5·10.

Infusible before the blowpipe *per se*.

Iserine, from decomposed basalt near Rheinbreitenbach, gave,—

Titanic acid	9·63
Red oxide of iron	51·86
Protoxide of iron	40·27
	101·76

Composition: $\dot{\mathrm{Fe}}\dddot{\overline{\mathrm{R}}}$, where $\dddot{\overline{\mathrm{R}}}$ is $\dddot{\overline{\mathrm{Fe}}}$ and $\dddot{\overline{\mathrm{Ti}}}$. The $\dddot{\overline{\mathrm{Ti}}}$ is supposed to be converted into $\ddot{\mathrm{Ti}}$ by combining with a portion of the oxygen in the $\dddot{\overline{\mathrm{Fe}}}$ during the analysis.

Occurs in crystalline grains, massive and disseminated in basalt, and in the form of sand in alluvium, or in the beds of rivers; it is frequently mixed with magnetic iron-sand.

Localities.—Occurs, according to Dr. Traill, on the shore of the Mersey, nearly opposite Liverpool, mixed with magnetite; and similarly at Hunstanton in Norfolk. In the bed of the Don, near its mouth, in Aberdeenshire; and on the shore of Loch Trista in Fetlar, one of the Shetlands. Rarely, imbedded in the trap-rocks of Arthur's Seat near Edinburgh; in minute octahedrons among boulders at Ballygrogan, Mull of Cantyre. Magnetic iron-sands, deposited by streams, at Granton, near Edinburgh, St. Andrews, Fife, and elsewhere, if not entirely consisting of this species, contain it in large quantity.

In the beds of some of the auriferous streams in the Co. Wicklow in Ireland.

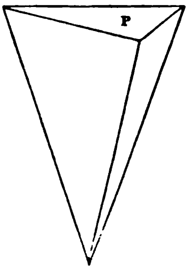
Note.—The sand referred to above, from the shore of the Mersey, yielded to Mr. Edwards, Ph.D., of Liverpool,—

Titanic acid	13·20
Protoxide of iron	31·10
Peroxide of iron	42·08
Alumina	8·62
Silica (? sand)	4·02
	99·02

Here alumina may replace a portion of the peroxide of iron. See Report of the British Association, Glasgow, 1855.

130. CRONSTEDTITE, *Phillips*.

Rhombohedral. Occasionally hemihedral, as a form resembling the subjoined figure may sometimes be recognized. Usually in radiating aggregrations, the crystals of which now and then terminate in hexagonal prisms. Cleavage very perfect parallel to *o*. The plane of cleavage somewhat curved in fibrous masses. Black. Streak dark green. Lustre vitreous, glossy. Brittle; in thin plates somewhat flexible. H. 2·5; Gr. 3·3 to 3·4.



In the closed tube gives off water. Before the blowpipe intumesces somewhat, and fuses on the edges to a blackish-grey magnetic slag. With borax and salt of phosphorus gives indications of iron, silica and manganese; of the latter also with soda on platina foil. Decomposed by hydrochloric and sulphuric acids, producing a jelly of silica.

Analysis of a Bohemian specimen by Kobell:—

Peroxide of iron	35·35
Protoxide of iron	27·11
Protoxide of manganese	2·89
Magnesia	5·08
Silica	22·45
Water	10·70
	103·58

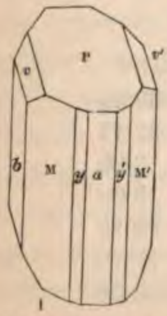
Formula, $\dot{F}e^2\ddot{S}i + \ddot{\bar{F}}e\dot{\bar{H}}^2$; with peroxide of iron, 36·80; protoxide of iron, 33·03; silica, 21·71; water, 8·46; part of the protoxide replaced by manganese and magnesia in the proportions of 1 of the protoxide of manganese, 3 of magnesia, and 10 of the protoxide of iron; the per-centages being,—peroxide of iron, 37·88; protoxide of iron, 24·29; protoxide of manganese, 2·46; magnesia, 4·29; silica, 22·36; water, 8·72. With perhaps one-fifth more water: new analyses desirable.

Occurred formerly in diverging fibrous groups of crystals, presenting the form of thin three-sided prisms, at Huel Maudlin, near Lostwithiel, Cornwall, disposed on siderite and decomposed pyrites.

It is one of the rarest British minerals. A few inferior specimens have been found recently since the mine has been again put in work.

131. VIVIANITE.—Phosphate of Iron, *Phillips.*

Oblique. Primary form an oblique rhombic prism. Cleavage very perfect parallel to *b*, traces parallel to *a*. Lustre, *b*, pearly, the other planes vitreous. Transparent, translucent; least transparent in direction perpendicular to *b*; opaque. Indigo-blue to blackish-green. By transmitted light, green at right angles to the axis, and pale-blue parallel to it. Powder and streak white, soon changing to indigo-blue. Sectile. In thin plates somewhat flexible. H. 2; Gr. 2·6 to 2·7.



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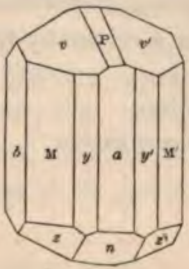

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P M	117°	40′
M M′	111	12
M *a*	145	36
P *a*	125	47
P *v*	149	35
M *b*	124	24
v b	120	25
y y′	154	14
y a	167	07
b r	109	34
b z	105	19
n a	144	20

b x 112° 53′ *b r* 109° 34′ *x n* 157° 07′

Combinations: M P*abv*; M P*abvy*; M*abvrzxn*; M P *abvz* (*y*), (*xr*), (*xrn*): *x* truncates M *z*. P is the face *w* of Brooke and Miller.

In the matrass gives off an abundance of water, intumesces, and becomes covered with red and grey spots. Fuses readily before the blowpipe to a magnetic bead. Easily soluble in nitric and hydrochloric acids. A solution of caustic potash extracts phosphoric acid; the solution, when neutralized with nitric acid, throws down a precipitate of phosphate of lead on the addition of acetic acid.

Analysis of a Cornish specimen by Stromeyer:—

Protoxide of iron . . .	41·22
Phosphoric acid . . .	31·18
Water	27·48
	99·88

$\dot{Fe}^3\overset{\cdot\cdot\cdot\cdot\cdot}{\not{P}}+8\dot{\not{H}}$; with protoxide of iron, 42·38; phosphoric acid, 28·69; water, 28·93.

LOCALITIES.—Occurs crystallized, in fibrous masses, lamellar, compact and in an earthy form. The finest crystals of this mineral ever found occurred formerly at Huel Kind, in St. Agnes, disposed on pyrrhotine with small crystals of siderite; some of these crystals were 2 inches in length and ¾ths of an inch across. In fine specimens at Huel Falmouth, in Kea; and in Parknoweth near St. Just.

In Devonshire fine specimens have been met with at Wheal Betsy near Tavistock. In large flat crystals at Wheal Jane, in Kea, on eisen-nickelkies. In both Cornwall and Devon, terminated crystals are rare.

In acicular and flattened crystals at Botallack and Parknoweth in St. Just. At Huel Kind, near St. Agnes.

Fine crystals from the interior of the horns of a fossil Irish elk are in the collection of the British Museum.

Compact in Parknoweth, St. Just.

Earthy at Parknoweth and Botallack.

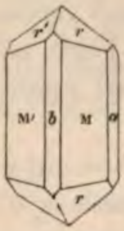
At the Odin mine near Matlock. In alluvium at Clifton near Bristol; in Toxteth Park near Liverpool; near Bury St. Edmunds; and in Norfolk. In mud, in the Isle of Dogs. Incrusting fossil bones and horns at Ballagh in the Isle of Man; likewise in peat-bogs there.

In cavities in chromite, and in bog iron-ore in Unst, Shetlands, where it also is found in peat-bogs. In soft friable clay, once forming a deposit, under old bone-heaps near the Castle Rock, Edinburgh. The earthy variety is frequently white when first dug up; it becomes blue on exposure to the atmosphere.

Named by Werner after J. G. Vivian.

132. SCORODITE.—Martial Arseniate of Copper, *Phillips*.

Prismatic. Primitive form a right rhombic prism. Cleavage imperfect parallel to *d*. Fracture uneven. Semi-transparent, translucent. Lustre vitreous to adamantine. Leek-green, bluish-green, liver-brown. Streak white. Rather brittle. H. 3·5 to 4; Gr. 3·1 to 3·2.



M M′	98°	02′
M *a*	130	59
M *b*	139	01
M *r*	145	29
r *r*′	114	34

d replaces the edge M *a*.

In the matrass gives off water and turns yellowish; exposed to a stronger heat produces a sublimate of arsenious acid. Melts upon charcoal to a grey magnetic slag with metallic lustre, with evolution of arsenical vapour. Easily soluble in hydrochloric, but not so in nitric acid. Solution of caustic potash extracts arsenic acid, oxide of iron being thrown down.

Hydrochloric solution gives no precipitate with solution of gold.

Analysis of a Cornish specimen by Damour :—

Peroxide of iron . . .	32·74
Arsenic acid	51·06
Water	15·68
	99·48

$\ddot{\bar{F}}e\overset{\cdot\cdot\cdot\cdot\cdot}{A}s+4\dot{\bar{H}}$; with protoxide of iron, 34·7 ; arsenic acid, 49·8 ; water, 15·5.

Probably the result of the decomposition of mispickel, with which it is frequently associated.

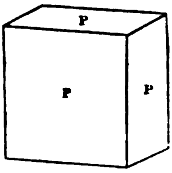
It was formerly found at Huels Gorland and Unity, and in several other mines near St. Day. It occurred in ferruginous quartz in minute crystals, and in orbicular, radiating groups of a pale bluish-green colour lining the interior of cavities, and occasionally along with pharmacosiderite.

Phillips and Bournon, by the latter of whom this mineral was called cupreous arseniate of iron, were probably led to imagine this species contained copper in consequence of its marked bluish-green colour, and from its being met with in those mines where various arseniates of copper occur.

The name is derived from σκόροδον, *garlic,* in allusion to the odour which it gives off before the blowpipe.

133. PHARMACOSIDERITE.—Arseniate of Iron, *Phillips.* Cube Ore.

Cubic. Primary form, the cube. Cleavage P difficult to obtain, imperfect. Lustre adamantine to greasy. The faces of the cube sometimes striated parallel to their intersections with the faces of *o,* or curved; *o* and *p* often hemihedral, and frequently somewhat curved. Colour green of various shades to honey-yellow and brown. Semi-transparent, translucent on the edges. Streak light-green or yellow. H. 2·5 ; Gr. 2·9 to 3.



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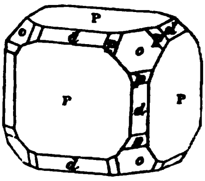

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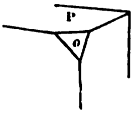

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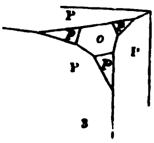

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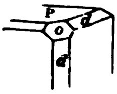

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P P 90° 00′	*o′ o′* 72° 32′	P *o* 125° 16′	*p p* 152° 44′
d d 120 00	P *p* 109 28	*d o* 144 44	*d p* 160 32
o o 109 28	P *d* 135 00	*o p* 164 12	

Combinations: P; *ò*; P *ò*; P *òp*; P *ò d*; P *ò dp*: *p* and *ò* are usually hemihedral.

In the closed tube gives off water and becomes red, intumescing slightly upon charcoal; fuses, with strong smell of arsenic, to a steel-grey magnetic slag; easily soluble in acids; solution of caustic potash extracts a portion of arsenic acid, with deposition of black anhydrous protoxide of iron.

Analysis by Berzelius:—

Peroxide of iron . . .	37·82
Arsenic acid	40·20
Phosphoric acid . . .	2·53
Oxide of copper . . .	0·65
Water	18·61
Earthy matter	1·76
	101·57

$3(\dddot{\mathrm{F}}\mathrm{e},\overset{\cdot\cdot}{\dddot{\mathrm{A}}}\mathrm{s}+5\dot{\mathrm{H}})+3(\dot{\mathrm{H}}\dot{\mathrm{F}}\mathrm{e})$.

Professor Naumann, owing to the excess of weight obtained in the analysis of Berzelius, is inclined to suppose that this mineral contains both the oxides of iron, and proposes the above formula, written $\dot{\mathrm{F}}\mathrm{e}\dddot{\mathrm{F}}\mathrm{e}\overset{\cdot\cdot}{\dddot{\mathrm{A}}}\mathrm{s}+6\dot{\mathrm{H}}$, which would require

40·13 of the two oxides of iron (27·70 peroxide and 12·43 protoxide), 40·77 arsenic acid, and 19·10 water. Professor G. Rose remarks in his 'Krystallochemische Mineralsystem,' that if that formula represents truly the constitution of this mineral, it offers the only instance of a triple binary compound, the crystalline form of which belongs to the cubic system. In chemical constitution this species is, however, probably allied to scorodite, in which Damour has shown protoxide of iron to be absent, and this consideration leads G. Rose to suppose that pharmacosiderite may perhaps be represented as follows,—$3(\overset{\cdots}{\bar{F}}e\overset{\cdot\cdot\cdot\cdot\cdot}{A}s+5\dot{\bar{H}})+\dot{\bar{H}}^{3}\overset{\cdots}{\bar{F}}e$; with peroxide of iron, 38·15; arsenic acid, 42·11; water, 19·74; that is to say, a compound of 3 atoms of a substance allied to scorodite, but containing 1 atom more water, with a hydrated peroxide of iron corresponding to hydrargillite. The formula $\overset{\cdots}{\bar{F}}e^{3}\overset{\cdot\cdot\cdot\cdot\cdot}{A}s^{2}+12\dot{\bar{H}}$; with peroxide of iron, 41·53; arsenic acid, 39·78; water, 18·69, also agrees well with the analytical results.

Localities.—Has been found lately in minute tetrahedral crystals at Wheal Jane, in cavities of iron pyrites. It occurred formerly in considerable abundance in a quartzose gossan at Huels Gorland and Unity in Gwennap; at Carharrack mine, near St. Day, in small yellowish crystals; at Carn Brae near Redruth, and at Botallack.

It has lately been found in small but very brilliant cubes at Burdle Gill, Cumberland, on quartz and decomposing limnite, the crystals sometimes with an iridescent tarnish.

The above figures and combinations represent Cornish specimens in Mr. Greg's collection.

The name is derived from *φάρμακον, poison,* and *σίδηρος, iron.*

134. BEUDANTITE.—Beudantite, *Levy, Mohs, Hausmann, Dana,* &c.

Rhombohedral. Cleavage parallel to *o* easily obtained. The faces P bright but curved, *o* flat but dull. Colour black, brown, opaque, but translucent in thin fragments, and of a deep brown colour by transmitted light. Lustre resinous. Streak greenish-grey. H. 4 to 4·5.

P P′ 91° 18′ *s s*′ 78° 51′ *s o* 116° 53′

Combinations: P; P *o*; P *s*; P *o s*. See figures of Susannite, P 100; *o* 111; *s* $\bar{1}11$.

P P′ varies somewhat; the above is the angle of the Cork specimens according to Dauber; that of the Horhausen, according to Levy, is 92° 30′, according to Dauber, 91° 48′; of the Montabaur in Nassau, 91° 9′, according to Dauber.

Before the blowpipe gives out much water; reduced with soda on charcoal gives a malleable bead which contains lead as well as iron and arsenic: the soda becomes sulphuret of sodium. By the malleability of the bead it may be distinguished from pharmacosiderite.

Analyses: *a* and *b*, from Horhausen, in Nassau, by Percy; *c*, from Cork, by Rammelsberg:—

	a.	*b.*	*c.*
Peroxide of iron . .	42·46	37·65	40·69
Oxide of lead	24·47	29·52	24·05
Oxide of copper . . .	. . .	. . .	2·45
Sulphuric acid . . .	12·31	12·35	13·76
Phosphoric acid . . .	1·46	not det.	8·97
Arsenic acid	9·68	13·60	0·24
Water	8·49	8·49	9·77
	98·87	101·61	99·93

Formula, $2\dot{\mathrm{P}}\mathrm{b}^3\dddot{\bar{\mathrm{P}}}+\dddot{\bar{\mathrm{F}}}\mathrm{e}\dddot{\bar{\mathrm{P}}}+9\dddot{\bar{\mathrm{F}}}\mathrm{e}\dddot{\mathrm{S}}+27\dot{\bar{\mathrm{H}}}$; with peroxide of iron, 38·90; oxide of lead, 27·50; sulphuric acid, 14·82; phosphoric acid, 8·80; water, 9·98.

In the Horhausen variety arsenic acid replaces the phosphoric, and it would seem to have only 24 atoms of water. (See Poggendorff's 'Annalen,' 1857, vol. c. No. 4, p. 581.)

LOCALITIES.—*Ireland.* At the Glendore iron-mine, near

Cork, where it was found in 1856 by Dr. Krantz. On specimens from this locality Rammelsberg performed his analysis which determined the specific individuality of this substance, which, on account of the obtuseness of the rhombs, and from the faces being much curved, had previously been confounded with pharmacosiderite. The crystals from this locality are very distinct and brilliant though small, and much resembling crystals of pharmacosiderite of a brown colour and translucent; the forms *o* and *s* appear to be rare or very small: the matrix is quartz and gossan.

135. MELANTERITE.—Sulphate of Iron. Green Vitriol.

Oblique. Primary form an oblique rhombic prism of 97° 39′ and 82° 21′. Cleavage perfect parallel to P. Fracture conchoidal. Colour leek-green and mountain-green, often yellowish towards the surface. More or less pellucid. Streak white. Rather brittle. Taste astringent. H. 2; Gr. 1·8 to 1·9.

In the matrass melts in its water of crystallization, which escapes, leaving as a residue the anhydrous salt, which is white; on charcoal produces oxide of iron in the oxidizing flame.

	Protoxide of iron .	27·19
$\dot{\mathrm{F}}\mathrm{e}\dddot{\mathrm{S}}+7\dot{\text{Ħ}}$	Sulphuric acid . .	31·02
	Water	41·79
		100·00

Distinct crystals very seldom occur in nature, the usual forms in which the substance is found being stalactitic, botryoidal, reniform, or in incrustations. It originates in the decomposition of pyrites.

LOCALITIES.—*England.* Specimens in large and tolerably distinct crystals may be obtained in fuller's-earth pits in the neighbourhood of Bath, at Widcomb Hill; a fine specimen from this locality is preserved in the Museum at Bath.

Occasionally found in the coal mines of Lancashire.

Formula, $\dot{\mathrm{F}}\mathrm{e}\ddot{\mathrm{S}}\mathrm{i}+6\dot{\bar{\mathrm{H}}}$; with silica, 33·5; protoxide of iron, 26·6; water, 39·9.

Discovered by D. Macculloch in the amygdaloidal trap of Scuir More in Rum. Also in Fife.

In thin crusts in chalcedony in Antrim; and in small botryoidal groups in vesicular greenstone at Down Hill.

Generally throughout amygdaloidal rocks.

Named from χλωρὸς, *green*, and φαιὸς, *brown*.

139. GREEN EARTH.—Grünerde. Glauconite. Kirwanite, *Thomson.*

In small masses in the cavities of amygdaloidal rocks; sometimes pseudomorphous after augite, or perhaps a decomposed or altered augite. Fracture earthy, glimmering, dull. Colour darkish-green. Opaque, slightly sectile. Soft, friable. Gr. 2·79 to 2·83.

The name of green earth has been applied to different compounds resembling one another in colour and composition; as in all probability the Glauconite and Kirwanite of Thomson. Some varieties of green earth may be referred to the species chlorite; others to augite.

Analyses: *a*, from Fassa, Tyrol, by Rammelsberg; *b*, from Mount Baldo; *c*, from Iceland; *d* (*Kirwanite*), Ireland, Thomson; *e* (*Glauconite*), from the greensand of Poke Hill, New Jersey; *f*, from that of Skulltown, New Jersey, both by Rogers; *g*, green earth in the form of augite, from Pozza, by Rammelsberg:—

	a.	*b.*	*c.*	*d.*	*e.*	*f.*	*g.*
Silica	45·87	51·25	52·04	40·5	50·75	51·50	45·87
Alumina . . .	11·18	7·25	4·93	11·4	6·50	6·40	11·18
Protoxide of iron	24·63	20·72	25·54	24·0	22·14	24·30	24·63
Magnesia . . .	0·28	6·16	4·26	...	...	...	0·28
Lime	1·50	...	1·38	19·8	...	...	1·50
Potash . . .	6·72	6·21	6·03	...	12·96	9·96	6·72
Soda		1·92	...	...	...	...	...
Water	9·82	6·49	5·19	4·3	7·50	7·50	9·82
	100·00	100·00	99·37	100·0	99·85	99·66	100·00

137. FAYALITE.—Anhydrous Silicate of Iron.

Prismatic. Cleaves with facility in two directions, making right angles with each other (Professor Naumann says a very obtuse angle). Dark brown, with semi-metallic lustre in places. Opaque. H. 6 (in specimens from Fayal, 6·5); Gr. 3·9 to 4·1. Affects the magnet.

Before the blowpipe it melts easily and without intumescence into a black shining globule. Partially decomposed by concentrated hydrochloric acid, a jelly of silica being formed.

Analysis from Slievecarrach, by Thomson:—

Protoxide of iron	68·73
Protoxide of manganese . .	1·78
Silica	29·60
	100·11

$\dot{\mathrm{F}}\mathrm{e}^{3}\ddot{\mathrm{S}}\mathrm{i}$; with silica, 29·55; protoxide of iron, 70·45.

It occurs in small detached masses at Slievecarrach, one of the Mourne Mountains; and Colonel Portlock reports it also from Tullybrick, Ballinascreen, with iron-flint, and from the foot of Slieve Gallion, in Londonderry. In composition it is an iron-olivine.

138. CHLOROPHÆITE, *Macculloch.*

Massive, incrusting, or disseminated in small grains or nodules, in basalt or amygdaloid. Fracture conchoidal. When first exposed, translucent and pistacio or olive-green, but soon changes to dark-brown and opaque. Soft, brittle. Lustre slightly glimmering. H. 1·5 to 2·0; Gr. 2·02.

Analysis of a specimen from Faröe, by Forchammer:—

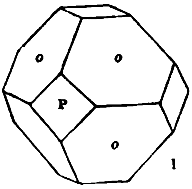
Silica	32·85
Protoxide of iron	22·08
Magnesia	3·44
Water	41·63
	100·00

Before the blowpipe emits copious arsenical fumes and fuses into a blackish scoria containing iron and sometimes silver.

In England formerly occurred in cavities of cobalt pyrites, probably at Wheal Sparnon in Cornwall.

141. PYRITES.—Iron Pyrites, *Phillips.*

Cubic. Cleavage parallel to P and *o*, more or less perfect. The faces P usually striated. Fracture uneven or conchoidal. Twins; twin-face *o*; *e* and *s* frequently hemihedral with parallel faces. Brass-yellow, sometimes inclining to gold-yellow, often brown, rarely iridescent. Streak brownish-black. Opaque. Emits sparks when struck with steel. H. 6 to 6·5; Gr. 4·9 to 5·1.



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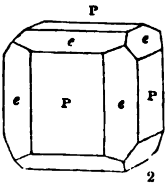

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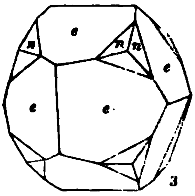

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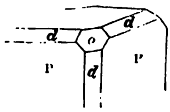

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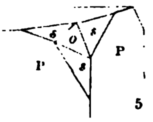


5

P P	90° 00′	*e o*	140° 16′	*n o*	160° 32′	*d d*	120° 00′
o o	109 28	P *s*	143 18	*n a*	144 34	*d o*	144 44
P *o*	125 16	*o s*	157 47	P *d*	135 00	*s s*	148 50
P *e*	153 26	*d e*	161 34	P *t*	150 48	*t o*	151 52

British forms: P; *o*; *e*; P*o*; P*e*; P*s*; *on*; *en*; *es*; P*oe*; P*no*; P*ne*; P*neo*; *de*; P*d*; P*dn*; P*de*; P*ntd*; P*do*.

In the matrass yields a sublimate of sulphur and gives off sulphurous acid. Before the blowpipe on charcoal burns with a blue flame. Melts readily to a black magnetic globule crystalline on the surface. Hardly acted on by hydrochloric acid. Soluble in concentrated nitric acid, leaving a residue of sulphur.

$\overset{''}{\mathrm{Fe}}$

Iron	45·75
Sulphur	54·25
	100·00

Pyrites is found in almost every kind of rock and formation, occurring crystallized, massive, disseminated, fibrous, in veins, globular, and reniform; also pseudomorphous. In coal, filling crevices in wood, and lining the interior of fossil ammonites and shells.

LOCALITIES.—*England*. It is an abundant mineral in Cornwall. Finely crystallized specimens have occurred lately at Lanescot mine; at Fowey Consols, St. Blazey; Wheal Mary near Redruth; Huel Maudlin, Lostwithiel; Huel Golden, Perranzabuloe: very large cubic crystals, several inches across, were formerly met with in Cornwall, probably from mines near St. Agnes; lately, also, at Wheal Maria, and Herodsfoot mine.

Devonshire; at Virtuous Lady mine near Tavistock, in cubes from the size of a pin's head to 1½ inch on the side, deeply striated and often beautifully iridescent, in decomposing chlorite. Crystallized (P *o* and P *o n*) in shells in a limestone quarry near Tiverton.

In octahedrons with the edges replaced in lias near Bath, in cubes in sandstone, Aust Passage. At Alston, in good specimens with barytes, pearl-spar, and quartz, as at Ogill Burn, Old Haggs, Garrigill, Coal Cluff, Rotherup Fells, and Silvergill. At Woodend near Keswick, and at Caldbeck Fells. At Allenhead and Nenthead. At Lewes, in brown octahedrons. At Pary's mine, Anglesey. Foxdale lead-mines, Isle of Man.

Scotland.—Near Dunoon, Argyleshire. Perthshire; at Leadhills. At Glendinning, Dumfriesshire.

Ireland.—In large cubes in hornblendic slate at Prehen and Hollywell Hill near Derry. At Tullybrick, Ballynascreen; Kilkree, Co. Clare; Kildrum and Goldenbridge, Co. Dublin. It is worked in large quantities at Ballygahan mine at Glandore in Wicklow, whence it is sent to Liverpool, where sulphur is extracted from it, and where it is also employed in the manufacture of sulphuric acid and sulphate of iron.

Hepatic Pyrites.—Cornwall.

At East Tullock, south of Loch Tay.

? In reniform concretions in the chalk and marls of Kent and Sussex.

Auriferous Pyrites, in large cubes of a brownish colour, containing visible particles of gold, has been found by Professor Tennant on Lord Breadalbane's estate, about eight miles from Glencoe.

Pseudomorphous Pyrites occurs at Herodsfoot lead-mine near Liskeard; and at Wheal Mary, Crowan. Near Tavistock in the form of flat hexagonal crystals after calcite, associated with minute crystals of Childrenite. In hollow cubes after fluor, at Alston.

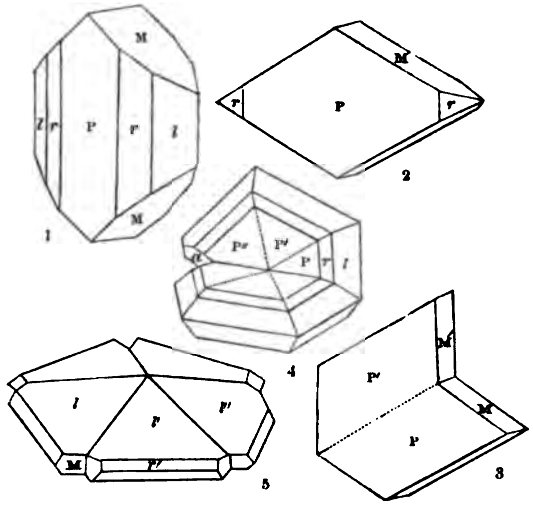
For the purpose of obtaining sulphur from this mineral it is heated in clay retorts, by which process about 17 per cent. of the sulphur is distilled over and is collected; what remains is thrown into heaps, and exposed to the oxidating influence of the atmosphere, being moistened from time to time. It is then lixiviated; the sulphate of iron formed being thus dissolved, is collected in ditches made for that purpose, and concentrated by evaporation until it is obtained in crystals.

Whenever large masses of iron pyrites undergo decomposition, considerable heat is evolved, and to such an evolution of heat is sometimes attributed the spontaneous combustion of coal-mines.

The name *pyrites* is derived from the Greek word πυρίτης, signifying "full of fire," alluding probably to its emitting sparks when struck with steel.

142. MARCASITE.—White-iron Pyrites, *Phillips*.

Prismatic. Primary form a right rhombic prism. Cleavage parallel to M, indistinct. Fracture uneven. Brittle. Lustre metallic. Greyish brass-yellow, sometimes inclining to greenish-grey, not unfrequently tarnished. Streak dark greenish-grey; very liable to decompose. Twin-face M. When triturated emits a smell of sulphur. H. 6 to 6·5; Gr. 4·65 to 4·88.



M M 106° 05′	P *r* 163° 30′	P *a* 90° 00′	P *s* 116° 55′
P M 90 00	P *l* 130 10	P *z* 149 22	

Combinations: M P *r*; M P *r l*; M P *r z l*; M *r l*; P *a r l*; M P; twinned. In Derbyshire also, M P *r z l s*. The face *s* replacing the edge between P and M; *z* the edge *r l*.

Comportment before the blowpipe and with acids same as that of pyrites.

$\overset{''}{\mathrm{Fe}}$		
	Iron	45·75
	Sulphur	54·25
		100·00

Marcasite and pyrites being identical in composition, it follows that $\overset{''}{\mathrm{Fe}}$ is dimorphous.

It occurs crystallized, stalactitic, fibrous, fibro-columnar, botryoidal, globular, and pseudomorphous. Usually met with in the newer rocks and in coal, marl, clay, &c. Is a less common mineral than pyrites.

LOCALITIES.—*England*. In Cornwall marcasite has occurred at Cook's Kitchen and East Pool, Illogan; at Wheal Unity, Gwinear; in the form of figure 2 at Wheal Crowndale; stalactitic and radiated at East Wheal Rose, near Newlyn, and other mines. At Fowey Consols, Tywardreath.

Devonshire; very fine aggregated crystals, of the form of figure 1, have been found lately at Virtuous Lady mine, near Tavistock, on crystallized quartz.

Fine specimens also occur at the various Tamar silver-lead mines, Beerferris. At Combmartin.

Kent; near Folkestone and Dover, imbedded in grey chalky marl, in aggregated crystals of the form of figure 4. In the Isle of Sheppey.

Also in the form of figure 4, or in nodules, in the chalk and marl of many parts of the south-east coast of England, as at Beachy Head, and likewise at Matting Hill.

Wiltshire; at Devizes.

Derbyshire; near Castleton in very perfect crystals, like figures 1 and 3, with cawk and galena.

In crystals of the form of figure 4 at Garrigill, near Alston Moor, Cumberland, on crystals of calcite.

Scotland.—In the Alva mine, Stirlingshire.

Ireland.—In the neighbourhood of Dublin; at Kilkee, Co. Clare, in lance-shaped crystals.

Figure 2 represents a crystal from Saxony.

The variety termed *cockscomb pyrites* is formed by an aggregation of crystals of the form of figure 1. Fine specimens may be found in the attle-heaps at Wheal Crebor, near Tavistock.

Pseudomorphous, after calcite, at the Tamar mines near Beerferris, formerly; in low hexagonal prisms slightly modified.

The *lonchidite* of Breithaupt, from λόγχη, *a spear*, is a variety of marcasite containing arsenic, which is of not uncommon occurrence at localities where it is associated with barytes and fluor, the quantity of arsenic not, however, usually exceeding 1 per cent. This variety may be occasionally observed in very small thin crystals or rosettes, in the form of figure 5, of a tin-white colour, or tarnished, upon old specimens of blistered copper-ore from Cook's Kitchen. Its analysis by Plattner gave,—

Iron	44·225
Arsenic	4·396
Cobalt, lead and copper	0·337
Sulphur	49·612
	98·570

Rammelsberg is disposed to look upon it as a combination of the isomorphous compounds $\overset{\prime\prime}{\mathrm{Fe}}$, marcasite, and $\overset{\prime\prime}{\mathrm{Fe}} + \mathrm{FeAs}$, mispickel, in the proportion of 88·79 of the former to 9·57 of the latter.

Koch, in his 'Vergleichungen mineralischer Benennungen,' derives the word marcasite from an Arabic word, signifying, "like a shining, fire-giving stone."

143. PYRRHOTINE, *Breithaupt, Haidinger*; Magnetic Iron-pyrites, *Phillips*; Magnetkies, *Hausmann*; Fer Sulfuré Magnétique, *Hauy*.

Rhombohedral, hexagonal. Cleavage basal, perfect. Fracture small, conchoidal and imperfect. Opaque. Lustre metallic. Brass-yellow inclining to reddish-brown; acquires a tarnish. Streak greyish-black. Feebly magnetic. H. 3·5 to 4·5; Gr. 4·65.

Infusible *per se*. On charcoal melts in the inner flame into a greyish-black highly magnetic bead. Insoluble in muriatic acid, leaving a residue of sulphur.

Analyses: *a*, from Fahlun, by Plattner; *b*, from Bodenmais, by H. Rose; *c*, from Sion, by Berthier:—

	a.	*b.*	*c.*
Iron	59·72	61·02	61·0
Sulphur	40·22	39·10	39·0
	99·94	100·12	100·0

Formula, $\overset{\prime}{F}e^{5}+\overset{\prime\prime\prime}{\bar{F}}e$; with iron, 59·60; sulphur, 40·40.

Rarely found distinctly crystallized; usually massive, also lamellar and disseminated. Occurs principally in the older rocks, with magnetite and copper pyrites.

LOCALITIES.—*England.* Cornwall; at Botallack near St. Just, and near Truro; cleavable and massive at Wheal Maudlin.

Devon; at Beeralston.

Carnarvonshire; at (?) Trifriew. At the foot of Moel Elion, and near Pont-aber-glaslyn ?.

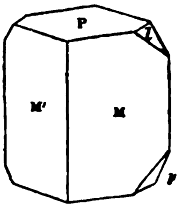
Scotland.—Massive at Appin in Argyleshire; also, with a fine crystalline texture, accompanying eisen-nickelkies, on the Duke of Argyll's property near Inverary. In the Galloway Hills.

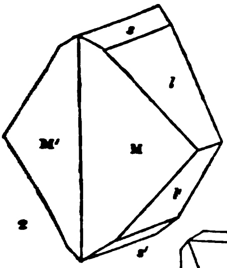
Ireland.—Of a bronze colour near Leahtown in Donegal. Said to occur in a greenstone-dyke in the parish of Drumkeeran in Fermanagh.

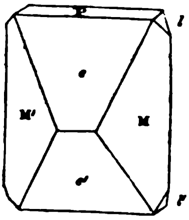
144. MISPICKEL.—Arsenical Iron, *Phillips.*

Prismatic. Primary form a right rhombic prism. Cleavage parallel to M tolerably distinct. Fracture uneven, brittle. Colour silver-white to nearly steel-grey; sometimes with a reddish-brown tarnish. H. 5·5 to 6; Gr. 6 to 6·2.

In the matrass gives first a red and then a brown sublimate of sulphuret of arsenic, afterwards metallic arsenic sublimes; on charcoal, after the arsenic is driven off, a black magnetic







M M'	111° 22'
M P	90 00
l l'	100 38
s s'	62 08
r r'	33 32
e e'	120 48
s l	159 50

Combinations: Cornwall, M P; M P *l e*; M *r*; M *l*; M *l s*; M *r e*; M *l e*: *r* truncates the edge P *s*.

globule is left, which behaves like magnetic pyrites. Soluble in nitric or in nitromuriatic acid, leaving a residue of sulphur and arsenious acid.

Iron	33·57
Sulphur	19·90
Arsenic	46·53
	100·00

$\overset{''}{Fe} + FeAs^2$.

It occurs in imbedded and attached crystals, frequently united in druses, in columnar masses, granular and disseminated.

Localities.—*England.* Its localities in Cornwall are so numerous that only a few, at which it is found in fine specimens, can be cited here. At Botallack and Huel Castle. At Cook's Kitchen, Illogan, recently, in large curved crystals of a tin-white colour. At Wheal Maudlin, Lostwithiel. At Dolcoath, Camborne; at Tincroft near Pool; at Carn Brae, Redruth; at Relistian mine in Gwennap, imbedded in chlorite; also at Unity Wood in the same parish. At Wheal Vor Consolidated mines in Breage. At Huel Unanimity, near St. Austell. An argentiferous variety occurred at Huel Providence in Gwinear, and at Wheal Mary near Redruth.

Devonshire; occasionally in remarkably fine crystals at the various Tamar mines near Beerferris.

Mispickel occurs in Cumberland at Brandygill, Carrock Fells, in quartz, and at Goldscope mine, near Keswick, at which latter locality it is auriferous.

Scotland.—In white limestone, with chondrodite, near Loch Ness; massive, in quartz, at Stonehaven, Aberdeenshire.

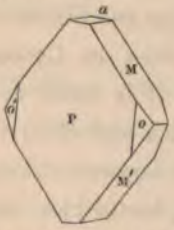
Crystallized, and of a white colour, fibro-lamellar, in quartz, at Faithleg, Co. Waterford.

Mispickel, which is very common in Cornwall, is worked as an ore of arsenic, the white arsenic of commerce being obtained principally from it.

Order V. MANGANESE.

145. PYROLUSITE, *Haidinger, Dufrénoy*. Varvicite ?.

Prismatic. Cleavage parallel to M and *a* indistinct; *a*, *b*, M striated parallel to their intersections with each other. Fracture uneven. Opaque. Colour dark steel-grey, light iron-black. Lustre metallic, bright. Streak black. Brittle. H. 2·0 to 2·5; Gr. 4·7 to 5·0.



M M'	93°	40'
M *a*	133	10
M P	90	00
P *o*	128	45

Combinations: P M; P M *o*; P M *a*; P M *o a*; on specimens from Hartshill in Dr. Heddle's collection.

Infusible *per se* before the blowpipe. On charcoal, in a strong heat, becomes reddish-brown. In the outer flame imparts a violet colour to borax. Soluble in muriatic acid, with evolution of chlorine.

Composition: $\ddot{\mathrm{M}}\mathrm{n}$; or manganese, 63·3; oxygen, 36·7.

Analyses: *a*, from Undenaes, by Arfvedson; *b*, from Ihlefeld, by Turner:—

	a.	*b.*
Red oxide of manganese . . .	83·56	85·62
Oxygen	14·58	11·60
Baryta	...	0·67
Silica	...	0·55
Water	1·86	1·57
	100·00	100·01

In attached crystals, fibro-crystalline, reniform, radiating and botryoidal masses; also compact and earthy, with psilomelane, limonite, Göthite, barytes and calcite.

Localities.—At some of the Cornish mines near Tintagel and St. Minvers, but is liable to be confounded with some of the other ores of manganese, and along with which it may also occur. At Creva Wood, Callington; (?) at Trebartha, near Launceston; (?) at the Indian Queen's mine, St. Denis; and (?) at Veryan, near Tregona.

Crystallized, as in the figure, in small crystals, at Hartshill, Warwickshire.

The *Varvicite* of Phillips is probably an accidental mixture of pyrolusite with psilomelane or manganite. It occurs fibro-lamellar and slightly radiating. Lustre submetallic. Colour steel-grey. Gr. 4·3.

Analysis by R. Phillips:—

Manganese	63·3
Oxygen	31·7
Water	5·0
	100·0

Some so-called specimens from Hartshill much resemble Polianite, and are associated with psilomelane.

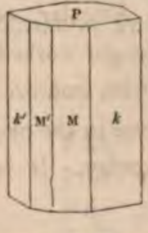
Occurs in considerable masses at Hartshill, in Warwickshire.

Pyrolusite parts with its oxygen at a red heat, and is much used for discharging the brown and green tints of glass, and for obtaining chlorine.

It derives its name from πῦρ, *fire*, and λύω, *to wash*. It may easily be distinguished from manganite by its inferior hardness.

146. MANGANITE.—Grey Oxide of Manganese, *Phillips*; Acerdèse, *Beudant*; Manganit, *Haidinger*, *v. Kobell*; Graubraunstein, *Hausmann*.

Prismatic. Primary form a right rhombic prism. Occasionally hemihedral. The crystals, which are always columnar, and usually consist of a combination of several prisms, are striated vertically, and are very frequently grouped in bundles, an arrangement based, properly speaking, on a law of twins; radiating, fibrous and massive, seldom granular. Cleavage perfect parallel to M. The face P rough. Opaque. Lustre imperfect metallic. Dark steel-grey, passing almost to iron-black, sometimes brownish-black, occasionally tarnished. Streak brown (when altered, black). Rather brittle. H. 3·5 to 4; Gr. 4·3 to 4·4 (when altered, 4·5 to 4·8). Is a good conductor of electricity.



M M′	99° 40′
M P	90 00
k k′	103 24

British forms: M P and M P *k*.

In the closed tube yields water. Infusible before the blowpipe. In the oxidating flame imparts an amethyst colour to borax, which disappears in the reducing-flame. Soluble in concentrated hydrochloric acid with evolution of chlorine. Concentrated sulphuric acid dissolves it only sparingly; the solution is of a faint pink tint.

Analysis of manganite from Ihlefeld, by Turner:—

$\dddot{\overline{\mathrm{M}}}\mathrm{n}\,\dot{\overline{\mathrm{H}}}$	Oxide of manganese	89·90
	Water	10·10
		100·00

Locᴀʟɪᴛɪᴇs.—*England*. Cornwall; in the manganese district from St. Minvers to Tintagel. Crystallized at Botallack mine, St. Just; near Pednandrea, as at Wheal Buckets, and at Callington. Acicular at the Royal iron-mines. Massive at Veryan, Trebartha, and at the Indian Queen mine. See "Pyrolusite."

Cumberland; at Burdle Gill, Caldbeck Fells; at Saddleback, near Keswick; and at Force Craig.

Devonshire; in fine crystals, of the form given in the figure, at Upton Pyne, near Exeter.

Somerset; at Churchill and other places in the Mendip Hills.

Warwickshire; lamellar and compact at Hartshill, near Atherstone.

Scotland.—Aberdeenshire; formerly at Granam, in the parish of Towie, beyond the Don, in crystals of the form of the figure, and also that of the primary form. Acicular, compact and earthy at the same mine, which is no longer worked.

Ireland.—Co. Dublin; near Howth with iron-ore. Clare; at Slieve-an-oir. Cork; abundant and pure in the neighbourhood of Ross, Leap, Noharval and Castleventry. It is worked at Kilfaunabeg, near Ross.

Manganite is applicable to the same uses as pyrolusite, to which, however, it is inferior for the purpose of obtaining oxygen or chlorine.

147. PSILOMELANE, *Haidinger*. Compact Grey Oxide of Manganese.

Amorphous. Massive, stalactitic, and botryoidal. Fracture flat, conchoidal. Opaque. Lustre sub-metallic. Streak bluish-black, shining. Colour iron- or bluish-black, passing into dark steel-grey. Brittle. H. 5 to 6; Gr. 3·7 to 4·3.

With blowpipe in the open tube yields water; gives a violet colour to borax, and is completely soluble in muriatic acid, excepting a small quantity of silica. In powder imparts a red colour to concentrated sulphuric acid.

Analyses: *a*, from Schneeberg, by Turner; *b*, from Beyreuth, by Fuchs; *c*, from Ilmenau, by Clausbruch:—

	a.	*b.*	*c.*
Red oxide of manganese	69·80	81·8	77·23
Oxygen	7·36	9·5	15·82
Baryta	16·36	...	0·12
Potash	...	4·5	5·29
Lime	...	...	0·91
Water	6·22	4·2	...
Black oxide of copper	...	...	...
Silica	0·26	...	0·52
	100·00	100·0	99·89

Formula, $\dot{R}\ddot{\bar{M}}n^2+\dot{\bar{H}}$, but mixed (? ?) with $\ddot{\bar{M}}n$.

Localities.—*England.* Usually found accompanying limonite and manganite. Cornwall; in splendid stalactitic masses, velvet-black, at the Withiel Royal iron-mines, Restormel, Lostwithiel.

Devon; at Upton Pyne near Exeter; at Burnt Tor, and near Bideford; at Orleigh Court; also at Black Down near Tavistock, in fine botryoidal and stalactitic specimens; at Ashton near Chudleigh.

At Drygill, accompanying kampylite, in Cumberland.

At Hartshill, Warwickshire.

Scotland.—Dumbartonshire; at Old Kilpatrick, near the

New Church, botryoidal and glossy-black. At Leadhills. At Braebrough, and the meadow of the Kame, Hoy, Orkneys; and, according to Dr. Heddle, in the same island at the Lead Gio, Hoy Head, in large and extremely fine specimens, both stalactitic, flat, and botryoidal, of a glossy-black, and accompanied by limonite. These specimens from Braebrough are peculiar, being small, columnar, and somewhat like coralloid; the matrix here is old red sandstone. In basalt in the Island of Rum.

Ireland.—At Glendore, Co. Cork; and in Co. Donegal, according to Patrick Doran.

Named from ψιλὸς, *smooth* or *naked*, and μέλας, *black*.

148. WAD, *Phillips*. Earthy Manganese. Manganschaum, *Hausmann*. Kakochlor, *Breithaupt*. Bog Manganese.

Amorphous. Occurs massive, botryoidal, reniform, and pulverulent; or in froth-like coatings, as on limonite. Lustre imperfect, metallic, feeble. Streak brown, shining. Soils. Very sectile. Unctuous to the touch. H. 0·5 to 1·0; Gr. 2·17 to 3·70.

In the matrass yields water. Reactions before the blowpipe same as in manganite.

Analyses: *a*, from Upton Pyne, by Turner; *b*, from Derbyshire; *c*, from Ilmenau, by Scheffler; *d*, from Austerlitz, by Beck:—

	a.	*b.*	*c.*	*d.*
Red oxide of manganese	...	38·59	...	58·50
Protoxide of manganese	73·60	...	66·5	...
Oxygen	14·34	...	12·1	...
Red oxide of iron . .	...	52·34	1·0	22·00
Baryta	...	5·40	8·1	...
Water	10·66	10·29	9·8	17·00
Silica	...	2·74	2·5	2·50
	98·60	109·36	100·0	100·00

Formula, $\dot{R}\ddot{M}n+\dot{\bar{H}}$, ? or $\dot{R}\ddot{M}n+2\dot{\bar{H}}$. ?

Minerals coming under the name of Wad, include doubtless various mixtures of different oxides, and cannot always be considered distinct species, or as having a very definite chemical composition.

Localities. — *England.* Near Redruth in Cornwall; at Wheal Buckets, Pednandrea, and Wheal Tolgus.

At Upton Pyne near Exeter, Devon, in very light masses of a dark-brown colour.

At several localities in Derbyshire, containing more or less barytes; near Middleton, an impure variety occurs in large brownish-black shining masses, having a slightly divergent and fibro-crystalline structure; when closely examined, it will be found to be merely sulphate of baryta highly impregnated with manganese, a cleavage fragment giving the angle 101° 42′ of barytes; at the Ball Eye mine near Bonsall.

Scotland.—At Leadhills, pseudomorphous after calcite, according to Heddle. Coating psilomelane, and in veins at Hoy Head, Orkneys; at which localities, containing cobalt and potash.

149. DIALLOGITE, *Haidinger*; Carbonate of Manganese, *Phillips*; Manganèse Carbonaté, *Hauy*.

Rhombohedral. Seldom found crystallized. Fracture uneven; imperfect conchoidal. Translucent in a slight degree. Lustre vitreous, inclining to pearly. Colour pale rose-red, flesh-red. Streak white. Brittle. H. 3·5 to 4·5; Gr. 3·43 to 3·63.

Decrepitates when heated. Infusible before the blowpipe, but grows blackish. With borax forms in the outer flame a violet-blue coloured enamel. Quickly soluble with effervescence in warm muriatic acid.

Analyses: *a*, from Freiberg, by Stromeyer; *b*, from Kapnik, by Berthier; *c*, from Nagyag; *d*, from Glendree, Co. Clare, by Dr. Kane:—

	a.	*b.*	*c.*	*d.*
Carbonate of protoxide of mang.	73·70	90·5	86·64	79·94
Carbonate of lime	13·08	9·5	10·58	2·43
Carbonate of magnesia . . .	7·26	...	2·43	...
Carbonate of protoxide of iron	5·76	...	...	11·04
Water	0·05	...	0·31	6·22
	99·85	100·0	99·96	99·63

Composition: $\dot{Mn}\ddot{C}$; with carbonic acid, 38·22; protoxide of manganese, 61·78; but usually the $\dot{Mn}$ replaced by $\dot{Ca}$, $\dot{Mg}$, $\dot{Fe}$.

Localities.—It is said to have occurred at Bovey Tracey, in Devon.

At the Hon. Mr. West's mines, near Oswestry, in Shropshire.

Botryoidal, with manganite or Varvicite, at Hartshill, in Warwickshire.

Also recently, forming a large layer 2 inches thick, of a yellowish-grey colour, at Glendree, near Tulla, Co. Clare, in Ireland.

A crystallized carbonate of lime, of a pinkish colour, from Nairtly Valley, Caernarvonshire, is reported to contain 9 per cent. of carbonate of manganese.

150. RHODONITE, *Beudant*. Manganese Spar. Bisilicate of Manganese, *Thomson*. Paisbergite. Allagite, &c.

Anorthic. Cleavage in three directions. Rarely crystallized. Usually massive. Fracture uneven, splintery. Translucent on edges. Lustre vitreous to pearly. Colour rose-red, flesh-red, inclining to brown, green, or yellow when impure. Streak reddish-white. Brittle. H. 5·5 to 6·5; Gr. 3·40 to 3·68.

Before the blowpipe on charcoal in the inner flame melts into a red semi-transparent glass; in the outer flame into a black globule. With borax in the outer flame melts into a violet glass. Not acted on by muriatic acid.

Composition: $\dot{M}n^3\ddot{S}i^2$; with silica, 45·9; protoxide of manganese, 54·1 = 100.

Contains generally a little lime, magnesia and iron. Rhodonite is considered to be a pure manganesian augite; the primitive form has, however, been lately shown, by crystals from Paisberg in Sweden, to be anorthic, and not, like common augite, oblique.

Localities.—At a manganese quarry 1½ mile S.E. from Callington, in Cornwall.

Devon; at Upton Pyne, and at Black Down near Tavistock.

Derived from *ῥόδον, a rose*, in allusion to its colour.

Order VI. NICKEL.

151. ANNABERGITE.—Annabergite, *Brooke* and *Miller*; Arseniate of Nickel, *Phillips*; Nickel Arseniaté, *Hauy*; Nickelblüthe, *Hausmann*.

Oblique. Apparently isomorphous with erythrine and Vivianite, but usually in short capillary crystals as an efflorescence, compact and earthy. Apple-green to greenish-white. Glistening to dull; more shining in streak. H. 2 to 2·5; Gr. 3 to 3·1.

In the matrass yields water. On charcoal emits fumes of arsenic, and shows the reaction of nickel. Easily soluble in acids.

Analyses: *a*, from Riechelsdorf, by Stromeyer; *b*, from Schneeberg, by Kersten:—

	a.	*b.*
Arsenic acid	36·97	37·21
Sulphuric acid	0·23	0·52
Oxide of nickel	37·35	36·10
Protoxide of iron	1·13	1·10
Water	24·32	23·92
	100·00	98·85

$\dot{\text{N}}\text{i}^3\overset{\cdot\cdot}{\overset{\cdot\cdot\cdot}{\text{As}}}+8\dot{\text{Ħ}}$; with arsenic acid, 38·4; oxide of nickel, 37·6; water, 24·0; a composition, as Kersten has shown, analogous to that of Vivianite.

It occurs at Wheal Chance, near St. Austell, along with arsenical nickel, and at Pengelly mine.

152. EMERALD NICKEL, *Silliman, jun.*

Incrusting, and often in small stalactitic mammillations, or sometimes appearing prismatic with rounded summits; also massive and compact. Lustre vitreous. Colour emerald-green. Streak paler. Transparent to translucent. Brittle. H. 3·0 to 3·25; Gr. 2·64.

In a matrass yields water and loses colour. With borax affords a transparent bead of yellowish-red colour when hot, and nearly colourless when cold. In the inner flame the bead is grey, from the particles of metallic nickel. Dissolves easily with effervescence in heated and dilute muriatic acid.

Analyses: *a*, by B. Silliman, jun.; *b*, by Smith and Brush, both from Texas, Lancaster Co., Pennsylvania:—

	a.	*b.*
Carbonic acid . . .	11·691	11·63
Oxide of nickel . . .	58·811	56·82
Water	29·498	29·87 $\dot{\text{Mg}}$ 1·68
	100·000	100·00

$\dot{\text{N}}\text{i}^3\ddot{\text{C}}+6\dot{\text{Ħ}}$; with oxide of nickel, 59·72; carbonic acid, 11·66; water, 28·62.

This rare mineral has recently been noticed by Dr. Heddle on chromate of iron, from Swinaness in Unst, one of the Shetlands. He supposes it to be the result of the decomposition of minute specks of eisen-nickelkies, disseminated through the chromate.

153. MILLERITE, *Haidinger*. Sulphuret of Nickel. Haarkies, *Mohs*.

Rhombohedral. The crystals showing hexagonal prisms of 120°, with the lateral edges replaced; terminations rarely distinguishable. Lustre metallic. Brass-yellow, inclining to bronze-yellow. Opaque. Streak bright. H. 3·0 to 3·5; Gr. 5·3.

In the open tube yields sulphurous acid. Before the blowpipe fuses readily to a brittle metallic globule. Imparts the colour of nickel to borax. With nitromuriatic acid yields a green solution.

A specimen from Saxony gave,—

Nickel	64·35
Sulphur	34·26
	98·61

$\acute{\mathrm{Ni}}$; with nickel, 64·86; sulphur, 35·14.

Localities.—*England*. Occurs in capillary filaments, filling cavities, and dispersed among crystals of other minerals. In argillaceous septaria at Ebbw Vale, near Merthyr-Tydvil, in S. Wales, in very fine specimens.

At Combe Martin in Devon; near Ilfracombe.

At Lanescot mine, Cornwall. At Wheal Chance, St. Austell, and at Pengelly mine, near St. Ewe.

Scotland.—Dr. Knapp found this mineral in a boulder-stone at Dunoon, on the shores of the Clyde.

Ireland.—It has been noticed by Professor Mallet at the foot of Croagh Patrick, Co. Mayo.

154. EISEN-NICKELKIES, *Scheerer*. Sulphuret of Iron and Nickel.

Cubic. Massive, granular. Fracture uneven. Lustre metallic. Colour light pinchbeck-brown, to light bronze-yellow. Streak rather darker. Not perceptibly magnetic. Brittle. H. 3·5; Gr. 4·5.

Chemical characters same as those of magnetic pyrites, except that the bead becomes black and opaque in consequence of the reduction of the nickel.

Specimens from Norway, analysed by Scheerer, gave,—

Iron	40·21	40·86
Nickel	21·07	22·28
Copper	1·78	...
Sulphur	36·64	36·86
	99·70	100·00

Composition: $2\acute{\mathrm{Fe}}+\acute{\mathrm{Ni}}$; with iron, 41·9; nickel, 22·1; sulphur, 36·0.

LOCALITIES.—*England.* With Vivianite, in large masses, recently at Wheal Jane in Kenwyn, Cornwall.

Scotland.—This mineral occurs in considerable quantity near Inverary, on the property of the Duke of Argyll. A mine is being worked at Essochossan Glen, two miles from Inverary; the ore was first discovered some years since in draining. The depth of the shaft is now 50 feet, and the mines produce about half a ton of ore daily (1853). There is another mine at Craignure on the side of Loch Fyne, about eight miles below Inverary; when searching for copper here, this ore was at first thrown aside in heaps as worthless, the existence of nickel in it being then unknown; for these heaps £30 a ton has since been refused.

At the Essochossan mine the ore is visibly mixed with pyrites and pyrrhotine, as well as with quartz.

A specimen of the rough ore taken and reduced to powder, gave on an average,—

Iron	43·76
Nickel	14·22
Sulphur	34·46
Silica	5·90
Lime	1·45
	99·79

Rejecting the silica and the lime, this mineral may be looked upon as a similar sulphide of iron and nickel to the eisennickelkies of Scheerer.

The following quantities of cobalt and nickel ores were raised in 1855:—

Cornwall; St. Austell Consols	39 tons.
Scotland. Argyleshire; mines belonging to the Duke of Argyll. From these there appears to have been raised, but not all sold, during the last two years	300 tons.
Cumberland; Coniston mines	3 tons.

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155. COPPER NICKEL, *Jameson*. Kupfernickel. Arsenical Nickel.

Rhombohedral. Rarely crystallized. Usually massive. Fracture uneven. Sometimes reniform and columnar, also reticulated and arborescent. Lustre metallic. Colour copper-red, with a greyish or blackish tarnish. Streak pale brownish-black. Brittle. H. 5 to 5·5; Gr. 7·3 to 7·7.

Before the blowpipe on charcoal melts, with evolution of arsenical vapours, into a brittle white magnetic globule.

In nitric acid assumes a green colour, and in nitromuriatic acid is dissolved.

$NiAs$; with arsenic, 55·98; nickel, 44·02; with small quantities of Sb; Co; Pb; Fe, and S.

Usually found accompanying ores of cobalt, bismuth, and silver.

LOCALITIES.—*England.* Cornwall; at Pengelly mine, St. Teath, and at Wheal Chance, St. Austell, with haarkies.

Quite recently a vein of nickel ore has been discovered at Fowey Consols mine, St. Day, 200 fathoms below the surface.

Scotland.—Formerly at the Hilderstone Hills, Linlithgowshire.

Nickel ores are now to some extent smelted at Cardiff and Swansea in South Wales.

Order VII. COBALT.

156. ASBOLANE. — Asbolane, *Brooke* and *Miller*; Earthy Cobalt, *Phillips*; Cobalt Oxidé noir, *Hauy*; Kobaltmanganerz, *Breithaupt*; Kobaltschwärze, *Hausmann*; Asbolan, *Haidinger*.

Amorphous. Fracture conchoidal to even. Opaque. Lustre resinous, glimmering, dull. Very sectile, approaching malleable. Bluish- and brownish-black. Soils somewhat. Streak black, shining. H. 1 to 1·5; Gr. 2 to 2·2.

In the matrass yields water. Before the blowpipe on charcoal does not melt. With borax and salt of phosphorus gives reactions of cobalt and manganese.

Analyses: *a*, from Camsdorf, by Rammelsberg; *b*, by Döbereiner:—

	a.		*b.*
Protoxide of manganese	40·05	Sesquioxide	34·71
Oxygen	9·47		...
Oxide of cobalt	19·45	Sesquioxide	35·47
Oxide of copper	4·35		...
Peroxide of iron	4·56		...
Baryta	0·50		...
Potash	0·37		...
Water	21·24		22·90
	99·44		93·08

The peroxide of iron in *a* was due to an admixture of limnite.

Formula of *a*, $(\dot{\mathrm{C}}\mathrm{o}\dot{\mathrm{C}}\mathrm{u})\ddot{\bar{\mathrm{M}}}\mathrm{n}^2+4\dot{\bar{\mathrm{H}}}$: of *b*, $\ddot{\bar{\mathrm{C}}}\mathrm{o}\ddot{\bar{\mathrm{M}}}+6\dot{\bar{\mathrm{H}}}$; with sesquioxide of cobalt, 38·39; of manganese, 36·66; water, 24·95.

Localities.—*England.* Occurs at Wheal Unity of a bluish-black colour; at Wheal Gorland, and at Roscommon Cliffs, in Cornwall.

Disseminated and in small veins in red sandstone at Alderley Edge, Cheshire.

Scotland.—Formerly at Breeton, near Alva, in Stirlingshire; and, according to Heddle, at Leadhills, with quartz.

Ireland.—Of a bluish colour, investing fissures, in clay-slate in the peninsula of Howth, near Dublin.

The name asbolane is derived from *ἀσβόλη, soot.*

157. ERYTHRINE, *Beudant*. Cobalt Bloom. Arseniate of Cobalt. Kobalt-blüthe.

Oblique. When crystallized usually in acicular and radiating crystals, or in stellated groups having a columnar structure; also earthy, investing and pulverulent. Colour crimson-red, peach-red, inclining to blue. Translucent, opaque, dull, earthy. H. 1·5 to 2·5; Gr. 2·95.

In the open tube gives off water and turns blue or greenish, and yields no sublimate. Before the blowpipe on charcoal emits arsenical vapours, and fuses in the inner flame to a dark-grey bead of arsenical cobalt. Imparts a smalt-blue colour to borax. Soluble in muriatic acid, forming a rose-red solution.

Analyses: *a* (crystallized), from Schneeberg, by Laugier; *b* (earthy), from Annaberg, by Kersten:—

	a.		*b.*
Arsenic acid . . .	38·43	Arsenious acid .	48·10
Oxide of cobalt . .	36·52	Arsenic acid . .	20·00
Protoxide of iron . .	1·01	Oxide of cobalt .	18·30
Water	24·10	Water	12·13
	100·06		98·53

Formula, $\dot{C}o^3\overset{\cdot\cdot\cdot\cdot\cdot}{A}s+8\dot{\bar{H}}$; with arsenic acid, 38·43; oxide of cobalt, 37·55; water, 24·02. The oxide of cobalt often partly replaced by $\dot{F}e$, $\dot{C}a$ or $\dot{N}i$: in the earthy cobalt bloom, arsenious acid replaces much of the arsenic.

Localities.—*England.* Cornwall; investing arsenical cobalt at Botallack mine, St. Just; at Wheal Polgooth, St. Austell; at Wheal Unity, St. Day; at Dolcoath mine, Camborne; with bismuth, at Wheal Sparnon, Redruth; at Wheal Trenwyth, St. Ives.

Devon; at Willsworthy mine.

Cumberland; at the Tyne-bottom mine, Alston; ? Force Craig, near Keswick.

Scotland.—At old lead-mines and refuse-heaps at Newton-Stuart, Galloway; ? near Tyndrum, in Perthshire; in small veins in limestone, in the coal formation on the Hilderstone Hills, Linlithgow; formerly at Alva, in Stirlingshire, with native silver and cobaltine.

Ireland.—At Muckruss, near Killarney, Co. Kerry, along with calc-spar, cobaltine and copper ores; at Bonmahon Head, Co. Waterford, with carbonate of copper.

158. SMALTINE, *Haidinger*; Tin-white Cobalt, *Phillips*; Speisskobalt, *Hausmann*; Octahedral Cobalt Pyrites, *Mohs*.

Cubic. Cleavages indistinct parallel to the faces of the octahedron and cube. Fracture uneven. Opaque. Lustre metallic. Colour tin-white, inclining to steel-grey. Streak greyish-black. Tarnishes slightly on exposure. Brittle. H. 5·5; Gr. 6·4.

Emits a smell of arsenic when broken. Before the blowpipe on charcoal emits arsenical vapours and melts into a grey magnetic globule, which is not malleable; fuses with borax into a blue glass. Soluble in nitric acid.

Analyses: *a*, from Riechelsdorf, by Stromeyer; *b*, from Tunaberg, by Varrentrapp:—

	a.	*b.*
Cobalt	20·31	23·44
Iron	3·43	4·95
Copper	0·16	...
Arsenic	74·22	69·46
Sulphur	0·89	0·90
	99·01	98·75

Formula, $CoAs^2$; with arsenic, 71·8; cobalt, 28·2.

Part of the cobalt sometimes replaced by nickel as well as iron. Smaltine occurs crystallized, but more frequently in arborescent, reticulated and amorphous masses; has not hitherto been observed in this country distinctly crystallized.

LOCALITIES.—*England.* Cornwall; lately at Wheal Sparnon near Redruth, arborescent and reticulated in quartz; at St. Austell Consols; Huel Herland; at the Wherry mine near Penzance, and at the Botallack mines, St. Just; at Wheal Polgooth, St. Austell; and lately also at Dolcoath mine, near Camborne.

Cumberland; at Force Craig, near Keswick, with cobalt bloom.

Scotland.—Argyleshire; at Essochossan Glen, two miles from Inverary, dispersed in small bright patches in eisen-nickelkies. Stirling; formerly with cobalt bloom at Breeton, near Alva. Said to have occurred in Linlithgowshire, at the Hilderstone Hills.

159. COBALTINE, *Haidinger*; Cobalt Gris, *Hauy*; Bright White Cobalt, *Phillips*; Hexahedral Cobalt-kies, *Mohs*; Kobaltglanz, *Hausmann.*

Cubic. Cleavage cubic. Fracture imperfect, conchoidal, uneven. Opaque; lustre metallic. Silver-white inclining to copper-red; slightly tarnished occasionally. Streak greyish-black. Brittle. H. 5·5; Gr. 6·2.

In the matrass unchanged. On the charcoal before the blowpipe emits arsenical fumes, and melts into a feebly magnetic globule. Soluble in warm nitric acid.

Analyses: *a*, from Skutterud, by Stromeyer; *b*, from Siegen, by Schnabel:—

	a.	*b.*
Cobalt	33·10	29·77
Iron	3·23	6·38
Arsenic . . .	43·46	44·75
Sulphur . . .	20·08	19·10
	99·87	100·00

Formula, CoS^2+CoAs^2; with cobalt, 35·5; arsenic, 45·2; sulphur, 19·3.

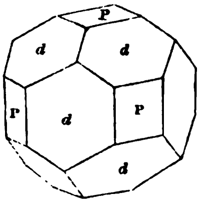
Iron sometimes largely replaces the cobalt.

A specimen of this mineral from Botallack mine, in Cornwall, is in Mr. Greg's collection; it occurs in small particles, interspersed in reddish quartz and chlorite; it was obtained and first noticed in this country by Mr. Rashleigh.

Order VIII. COPPER.

160. **COPPER.**—Native Copper. Cuivre natif. Oktaedrisches Kupfer.

Cubic. Crystals generally small, and usually much distorted and penetrating each other. Twins. Twin-plane *o*. Cleavage not observable. Fracture hackly. Opaque. Lustre metallic. Copper-red. Streak the same, bright. Malleable and ductile. H. 2·5 to 3; Gr. 8·3 to 8·9.



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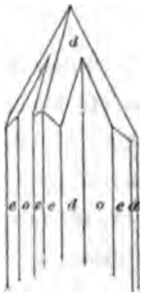
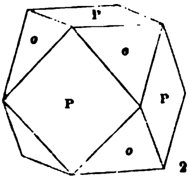


3

P P	90°	00′
d d	120	00
o o	109	28
P *o*	125	16
d o	144	44
P *d*	135	00
P *e*	153	26
e e′	143	08
d e	161	34



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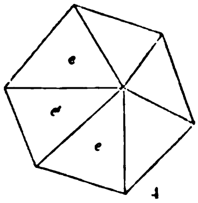

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Combinations observed in Cornwall: P; *d*; P*o*; P*d*; P*od*; *ee′*; *ea*; P*ed*; P*ode*.

Before the blowpipe fusibility=3. Moistened with hydrochloric acid on charcoal imparts a beautiful blue colour to the flame. Readily soluble in nitric acid, as also in ammonia, with access of atmospheric air, giving a blue solution. Cu, copper, generally almost pure.

Crystallized, frequently aggregated, thus producing mossy, dendritic, capillary, and laminar forms, also massive; in spear-shaped macles like figure 3. The largest masses of native copper that have been discovered in this country occur in the serpentine rock near the Lizard. Blocks have been met with weighing half a ton. The serpentine in which native copper occurs thus disseminated is worked into slabs for chimney-pieces and other ornamental purposes. Figure 4 represents a compressed twin crystal from Cornwall. Copper in the native state is met with more or less in very many of the Cornish and Devonshire mines; but the following localities deserve to be particularly mentioned:—

Cornwall; the Carn Brae mines produce octahedrons, externally dull brown; it occurs also at the same mines, in considerable quantities, in the form of plates. In fine crystals at Relistian mine, in Guinear. Ramose and mossy at Wheal Cock, Tolcarne and Botallack, all near St. Just. Formerly at Huel Music, near Porth Town. At Huel Vincent. At Huel Gorland, Gwennap, in cubes and octahedrons. At the United mines, in the same parish; Huel Virgin, near St. Day. At Wheal Buller, Redruth. Reticulated at Par Consols, near St. Blazey. Exceedingly well crystallized, dendritic and mossy native copper, recently, at Carn Brae, Illogan. At Condurrow, Camborne; and at West Caradon mine.

Devonshire; at numerous mines near Tavistock.

Anglesey; imbedded in serpentine.

Scotland.—In trap-rocks near Stirling. In several places in the Shetlands, as in Mainland, at Sandlodge mine, and in Yell in serpentine. In thin plates in the new red sandstone near the railway tunnel at Mauchline, in Ayrshire, and at Neilston, in Renfrew.

Ireland.—Crystallized and massive at Cronbane, in Wicklow; also at Ballymurtagh, in the same county, imbedded in bluish clay. At Knockmahon and Tigrony, in Waterford, crystallized and arborescent.

The value of the copper obtained from the principal copper-mines in Cornwall and Devon for the last few years will be found under the head of copper pyrites.

The following statistics and Tables are copied from Hogg's 'Business Man's Note-book':—

Summary of Copper produced from the Mines of the United Kingdom, and that smelted from Foreign Ores in 1855.

	Tons.	cwts.	qrs.	lbs.	£	s.
Total Copper produce of English Mines sold at Cornish Ticketings	12,578	11	0	23	1,263,739	6
Total Copper produce of Sales of Irish, Welsh, Foreign, and other Ores, at Swansea Ticketings .	5,926	1	2	14	654,468	11
Total Copper from Purchases by Private Contract	7,440	18	2	10	929,000	0
Ditto by Private Contract, not included in the above. (Estimated)	133	0	0	0	20,000	0
	26,078	11	1	19	2,867,207	17

Copper imported into the United Kingdom in the Year ending 31*st December* 1855, *and the two previous Years.*

	1855. Tons.	1854. Tons.	1853. Tons.
Copper Ore and Regulus	66,599	57,292	50,393
Copper unwrought and part wrought . .	8,044	3,218	5,200

Copper exported from the United Kingdom in the Year ending 31st December 1855, *and the two previous Years.*

Produce of the United Kingdom.

	1855. Tons.	1854. Tons.	1853. Tons.
Copper in Bricks and Pigs	5,124	3,040	4,780
Copper in Sheets, Nails, &c., including yellow Metal	10,416	9,534	9,804
Copper, wrought, of other sorts	1,103	1,103	1,047
Brass of all sorts	839	944	862

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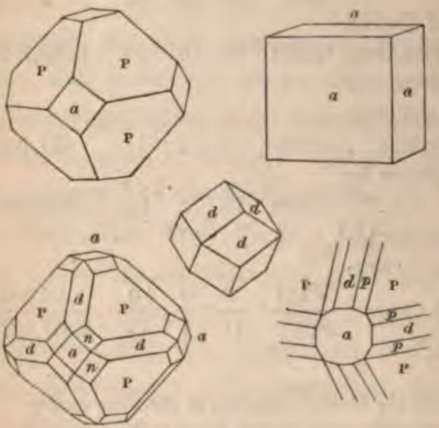
161. CUPRITE.—Red Oxide of Copper, *Phillips*; Plush Copper. Octaedrisches Kupfererz, *Mohs*; Cuprit, *Haidinger*; Cuivre Oxidulé, *Hauy*.

Cubic. Primary form the octahedron. Cleavage *o* tolerably perfect. Brittle. Colour cochineal-red to purple-red, reddish-brown. Lustre adamantine, inclining to metallic, in the impure variety called *tile-ore,* dull. Translucent to opaque. Streak brownish-red. Fracture conchoidal to uneven. H. 3·5 to 4; Gr. 5·7 to 6.



a a	90°	00′
P P	109	28
d d	120	00
P *a*	125	16
d a	144	44
n a	144	44
n P	160	32
p P	164	12
p d	160	32

Combinations: *a*; *d*; P; *a* P; *a* P *n*; *a* P *d*; *a* P *d n*; *a* P *d p*; P *d*; *a d*.

Before the blowpipe on charcoal becomes black at first, then fuses quietly, giving a globule of copper. In the forceps alone colours the flame pale green, moistened with hydrochloric acid deep blue. Soluble in hydrochloric and nitric acids, and likewise in ammonia. The concentrated hydrochloric solution produces a white precipitate of chloride of copper on the addition of water.

$\dot{\text{Ȼ}}\text{u}$	Copper	88·78
	Oxygen	11·22
		100·00

Occurs crystallized, granular, and in earthy masses. The crystals are seldom imbedded, usually attached or in druses. In speaking of the fibrous variety (the *chalcotrichite* of Glocker), Messrs. Brooke and Miller, in their recent work, say that it has been supposed by Suckow to be rhombohedral, and therefore to constitute a different species, but that Mr. Brooke has in his collection a series of specimens of this mineral from Cornwall and from Siberia, passing from moderately large and slightly elongated cubic crystals to very slender fibres, which still retain the square form. Another form, again, has been attributed to this variety by Kengott, who imagines it to belong to the prismatic system.

The principal localities of this species in England are in Cornwall and Devon, where it occurs in veins of tin and copper ore.

Cornwall; at South Wheal Francis near Redruth; at South and West Caradon mines, and at the Phœnix mines, near Liskeard; in good crystals at Huels Gorland, Unity, and Muttrell, three mines on the same lode, in Gwennap in granite and schist, accompanied by other ores of copper. Also well crystallized, formerly, at Huel Buller, and lately in fine crystals at Wheal Basset, Illogan; Huel Prosper, St. Agnes; at Polgear, Wendron; Huel Virgin, Gwennap; at Carharrack, St. Day; at Huel Charlotte, Huel Fanny, Huel Music, St. Agnes; at Tincroft near Pool; Huels Speed and Carvath, St. Ives; in fine cubo-octahedral crystals, Carnbrae, Illogan; at Botallack, St. Just. In the serpentine of the Lizard. At Gunnis Lake, Calstock.

Devonshire; at Wheal Crebor near Tavistock.

Staffordshire; lately, at the Ecton mine.

The fibrous variety, which is known in Cornwall by the name of *plush copper*, occurs in capillary crystals grouped together in bundles, and reticulated. It was formerly met with at Huel Gorland and the Consolidated mines in Gwennap; at Carharrack, St. Day; at Huel Prosper, St. Agnes; and at Owen Vein, St. Hillary.

In Devonshire it occurred recently of great beauty, and associated with pulverulent cuprite of rich colour, interspersed with native copper, at Bedford United mines near Tavistock.

The fibrous variety is also met with at Coosheen mine, Skull, Cork.

Ziegelerz, or *Tile-ore*, is the name which has been given to an earthy mixture of cuprite and hydrous oxide of iron, or cuprite and limonite. Colour brick-red or reddish-brown, according to the amount of iron it contains. Formerly at Gunnis Lake, Callington, and at Huel Muttrell, and now at several of the mines near Redruth; and at Wheal Edward, St. Just.

162. MELACONITE, *Dana*. Black Oxide of Copper. Kupferschwärze.

Occurs in pseudomorphous cubic forms. Pulverulent and earthy; also massive with a dull lustre. Streak shining. Lustre sub-metallic. Opaque. Gr. 5·2.

Contains,—

Copper	79·85
Oxygen	20·15
	100·00

Formula, $\dot{\mathrm{Cu}}$.

Probably the result of decomposition of Buntkupfererz or vitreous copper.

Localities.—*England.* Cornwall; lately with chrysocolla at Trefusis near Redruth. In granite at Hŭel Kayle in Gwinear. In gossan at Wheal Buller.

Cumberland; at Hay Gill and Roughten Gill, Caldbeck Fells.

Carnarvonshire; in limestone at the Great Orme's Head.

Scotland.—Rarely at Leadhills.

Ireland.—Kerry; many years since at Ross Island, Killarney. Mayo; earthy with malachite at Lackamore mine near Newport. Limerick; at Ballystein. Wicklow; at Cronebane.

163. PITCHY COPPER ORE is a mechanical mixture of limnite and chrysocolla.

According to Kobell, a variety from Turinsk contained,—

Red oxide of iron	59·0
Black oxide of copper	13·0
Silica	9·6
Water	18·0
	99·6

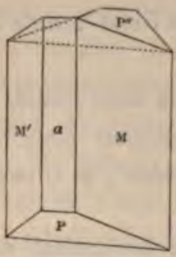
Colour dark brown. Lustre resinous. Fracture conchoidal. Usually associated with chrysocolla and iron pyrites.

Localities.—Occurs in Cornwall, at South Wheal Basset, in granite close to the veins of ore; formerly at Carharrack near St. Day; at Prince George mine in Gwinear; and at Ting Tang mine with chrysocolla.

Cumberland; at Roughten Gill, with malachite and copper pyrites.

164. MALACHITE.—Green Carbonate of Copper, *Phillips*; Malachit, *Haidinger*, *Naumann*; Malachite, *Beudant*.

Oblique. Primary form an oblique rhombic prism. Fracture conchoidal, uneven. Cleavage basic, very perfect. Translucent, or translucent on the edges, opaque. Lustre adamantine on planes of crystals, in aggregations silky to dull. Emerald-green, verdigris-green. Streak verdigris-green to apple-green. Brittle when crystallized, otherwise rather tough. Twin face *a*. Cleavage perfect parallel to P. P often rough. H. 3·5 to 4·0; Gr. 3·6 to 4·0.



M	P	112°	25′	
M′	M	103	42	
M	*a*	143	40	
P	P′	123	38	over summit
P	*a*	118	15	

Before the blowpipe on charcoal it blackens, and is readily reduced to a bead of copper. Soluble in acids with effervescence, also in ammonia.

Analysis of a Chessy specimen by Phillips :—

Oxide of copper	72·2
Carbonic acid	18·5
Water	9·3
	100·0

$\dot{\mathrm{Cu}}\ddot{\mathrm{C}}+\dot{\mathrm{Cu}}\dot{\text{Ħ}}$; with protoxide of copper, 71·9; carbonic acid, 19·9; water, 8·2.

When met with crystallized in Great Britain it occurs in twins, a peculiarity which it is believed holds good also at all foreign localities. Fibrous, reniform, and earthy. Pseudomorphous, in the form of cerussite, near Redruth.

LOCALITIES.—*England.* Cornwall; it is a common mineral, but always occurs in small quantity, and is usually met with where the red oxide is found. Specimens have been obtained at Carharrack, St. Day; Huel Husband and West Wheal Virgin. At Huel Music, St. Agnes. At Gunnis Lake, Callington; at Hewas tin-mine near St. Austell. At Wheals Unity and Gorland, and numerous other Gwennap mines. Botryoidal at Huel Edward, in St. Just. At Prince George mine.

Cumberland; well crystallized (see figure), acicular and fibrous, at Red Gill and Hay Gill near Hesket Newmarket. At Roughten Gill near the same place, and at Mexico mine on the road between the two. At Carrock End and Dale Head.

At Staveley, Westmoreland. Tyne Head, Durham. At Alderley Edge, Cheshire, sparingly, in sandstone. Somersetshire; formerly, at Doddington, and also at Buckingham mine near Bridgewater, in brown iron ore, with Chessylite. Derbyshire; with calcite, at Middleton, Hopeton, and Wensley. At Great Orme's Head, Carnarvonshire, staining crystals of calcite green. At Llanymynich Hill, six miles S.W. of Oswestry, in plumose specimens.

Scotland.—It is found at Castle Douglas, Kirkcudbrightshire. In very fine acicular crystals, almost equal to the Siberian specimens, at the old copper-mine, Sandlodge, North Unst; and at Dunrossness, Shetland. Fair Isle, between the Orkneys and Shetlands. Rarely, at Leadhills.

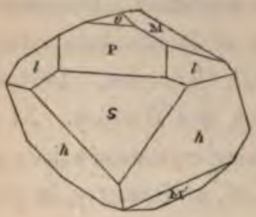
Ireland. — Fibrous and stalactitic at Silvermines, and at Lackamore mine, near Newport, Tipperary. In Waterford; at several copper mines, as at Knockmahon. Fibrous and radiated, with cerussite, in Limerick. Mammillated and fibrous at Muckruss, near Killarney, Kerry. In Wicklow; at Audley mine. In Cork; at the Classadaugh and Cappage mines, and in fine botryoidal specimens at the Coosheen mine near Skull.

Though pretty generally diffused in Great Britain, this species has not been met with in masses of sufficient size or beauty to admit of their being employed for ornamental purposes. Specimens have of late years been obtained from our Australian possessions which all but equal those from Siberia in beauty.

The name is derived from μαλάχη, *mallow*.

165. CHESSYLITE.—Blue Carbonate of Copper, *Phillips*; Azurite, *Beudant*; Lasur, *Haidinger*; Lasurit, *v. Kobell.*

Oblique. Primary form an oblique rhombic prism. Fracture conchoidal to uneven, and splintery. Transparent, translucent on edges, opaque. Lustre vitreous, approaching adamantine. Colour azure-blue, in earthy varieties smalt-blue. Streak smalt-blue. H. 3.5 to 4; Gr. 3·7 to 8.



M M	99°	32′
M θ	57	11
l l	119	16
h h	106	14
P *h*	111	46
P M	91	48
P θ	132	50
P *s*	135	13

The face P is the *c* of Brooke and Miller.

British forms: P *h l*; P *h l s*; P M *h l s* θ.

In the closed tube deposits water and turns black, before the blowpipe fuses and gives a bead of copper. Soluble with effervescence in acids, and likewise in ammonia.

Analysis of a specimen from Chessy:—

Oxide of copper	69·09
Carbonic acid	25·69
Water	5·22
	100·00

$2\dot{\mathrm{Cu}}\ddot{\mathrm{C}}+\dot{\mathrm{Cu}}\dot{\mathrm{H}}$; with protoxide of copper, 69·2; carbonic acid, 25·6; water, 5·2.

Occurs crystallized, massive, and earthy. Generally lining cavities or disseminated. Not so finely crystallized in this country as at various foreign localities, especially at Chessy; it is not a common ore of copper with us. It is probably the result of the decomposition of other copper ores; generally occurs associated with malachite.

Localities.—*England.* It has been met with in Cornwall at Wheal Buller near Redruth, of a beautiful colour, in the form of the figure, and also with the form P ς *h l*; in both cases the faces *h* predominating, so as to produce a slight distortion.

Formerly at Huels Gorland, Unity, Virgin, in Gwennap; at Carharrack near St. Day. At Ting Tang, in Gwennap, very prettily crystallized. At Huel Muttrell, formerly. Occurs, indeed, though sparingly, at most of the Cornish mines. Once, prettily crystallized at Wheal Mill Pool.

Devonshire; in good crystals, at East Tamar mine, Beerferris.

Formerly, in Somersetshire, at Buckingham mine near Bridgewater, in small but distinct crystals.

Derbyshire; with calcite at Middleton, Hopeton, Wensley, and Matlock. Staffordshire; at Breaston. Cheshire; at Alderley Edge, in sandstone, sparingly. Durham; at Wassinghope lead-mine. Carnarvonshire; at Great Orme's Head, with malachite and calcite.

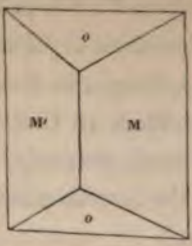
Scotland.—At Wanlock Head, Dumfriesshire, and Leadhills, Lanarkshire.

Ireland.—At Killarney; Audley mine, Wicklow; at Classadaugh near Four Mile Water, Cork.

166. LIROCONITE.—Liroconite, *Brooke* and *Miller*; Octahedral Arseniate of Copper, *Phillips*; Lenticular Copper. Cuivre Arseniaté Octaèdre Obtus, *Hauy*; Lirokonit, *Haidinger*; Linsenerz, *Naumann, v. Kobell, G. Rose.*

Prismatic. (According to Breithaupt oblique.) Primary form an obtuse rectangular prism, whose faces are inclined to each other 119° 20′ and 60° 40′. Cleavage imperfect parallel to *o* and M. Sky-blue to verdigris-green, streak paler. Lustre vitreous, inclining to resinous. Sectile. H. 2 to 2·5; Gr. 2·8 to 3·0.

Before the blowpipe does not decrepitate, on charcoal intumesces somewhat, and fuses without deflagration to a brownish slag enclosing white metallic grains. Easily soluble in nitric acid. Decomposed by solution of caustic potash, leaving a



M M′ 119° 20′
o o 107 38

black residue of oxide of copper. The caustic solution, when neutralized with nitric acid, gives a brownish-red precipitate on the addition of a solution of nitrate of silver.

Analyses: *a*, by Wachtmeister; *b*, by Hermann; *c* and *d* by Damour, all from Cornwall:—

	a.	*b.*	*c.*	*d.*
Oxide of copper . . .	35·19	36·38	37·18	37·40
Alumina	8·03	10·85	9·68	10·09
Peroxide of iron . . .	3·41	0·98	. . .	. . .
Arsenic acid	20·79	23·05	22·22	23·40
Phosphoric acid . . .	3·61	3·73	3·49	3·24
Water	22·24	25·01	25·49	25·44
	93·27	100·00	98·06	98·47

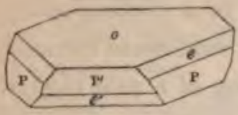
Formula, $5\dot{\mathrm{Cu}}^5\overset{\cdots}{\ddot{\mathrm{As}}}+\overset{\cdots}{\bar{\mathrm{A}}\mathrm{l}}^5\overset{\cdots}{\ddot{\mathrm{As}}}+75\dot{\bar{\mathrm{H}}}$; with oxide of copper, 37·92; alumina, 9·83; arsenic acid, 26·44; water, 25·81; some of the arsenic acid being replaced by phosphoric. $\dot{\mathrm{Cu}}^8\overset{\cdots}{\ddot{\mathrm{As}}}+\overset{\cdots}{\bar{\mathrm{A}}\mathrm{l}}^2\overset{\cdots}{\ddot{\mathrm{As}}}+24\dot{\bar{\mathrm{H}}}$; with oxide of copper, 36·61; alumina, 11·87; arsenic acid, 26·59; water, 24·93; agrees better with the first two analyses, the peroxide of iron being taken along with the alumina.

Was found in attached crystals, seldom massive, associated with other arseniates of copper, at Huels Muttrell, Gorland, and Unity, all in Gwennap, many years since, occasionally occurring in crystals ¾ of an inch across. It is not known to have been met with at any other Cornish mines.

The name *liroconite* is derived from λειρὸς, *pale*, and *κονία*, *dust*, in allusion to the pale colour of the streak.

167. TAMARITE.—Tamarite, *Brooke* and *Miller*; Rhomboidal Arseniate of Copper, *Phillips*. Copper Mica. Cuivre Arseniaté Hexagonal Lamelliforme, *Hauy*; Chalkopyllit, *Haidinger*; Kupferglimmer, *Werner*, *v. Kobell.*

Rhombohedral. Cleavage *o* very perfect; P, traces. Lustre; *o* pearly; P vitreous. Emerald-green, grass-green, verdigris-green. Transparent, translucent. Streak light-green. Sectile. H. 2; Gr. 2·4 to 2·6.



P P′	110°	12′
P′ *o*	108	44
e o	124	09
v o	124	09

Combinations: P *o*; P *o e*; P *o e v*: *v* truncates the edge P′ *o*. Before the blowpipe decrepitates violently, in powder gives off arsenical vapour, and fuses quietly to a brittle metallic bead, which, when fused with soda, gives a malleable globule of copper. Easily soluble in nitric acid. Decomposed by a solution of caustic potash, leaving a residue of oxide of copper. The solution, when neutralized with nitric acid, produces a brownish-red precipitate of arseniate of silver on the addition of a solution of nitrate of silver.

Analyses, by Damour, of Cornish specimens:—

Oxide of copper	52·92	52·30
Arsenic acid	19·35	21·27
Phosphoric acid	1·29	1·56
Alumina	1·80	2·13
Water	23·94	22·58
	99·30	99·84

$(\dot{C}u^{3}\overset{\cdot\cdot\cdot}{\ddot{A}}s+9\dot{\text{Ħ}})+3\dot{C}u\dot{\text{Ħ}}$; with arsenic acid, 24·9; oxide of copper, 51·7; water, 23·4.

Hermann's analysis of this mineral gives a result very different from the above, for he represents it by the formula

$\dot{\mathrm{C}}\mathrm{u}^{8}\overset{\cdot\cdot\cdot\cdot\cdot}{\bar{\mathrm{A}}\mathrm{s}}+23\dot{\bar{\mathrm{H}}}$, which may be more correctly expressed by $(\dot{\mathrm{C}}\mathrm{u}^{3}\overset{\cdot\cdot\cdot\cdot\cdot}{\bar{\mathrm{A}}\mathrm{s}}+18\dot{\bar{\mathrm{H}}})+5\dot{\mathrm{C}}\mathrm{u}\dot{\bar{\mathrm{H}}}$. This would require oxide of copper, 49·6; arsenic acid, 18·0; water, 32·4.

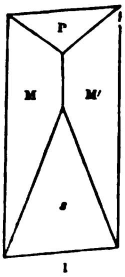
Generally in six-sided tabular crystals, of which the lateral planes are trapeziums, inclining alternately in different directions.

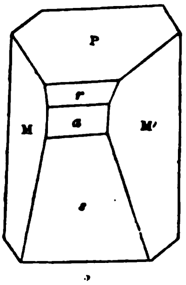
This species has been met with at Huels Gorland, Muttrell, and Unity, all in Gwennap; and likewise at Ting Tang in the same parish; also at Wheal Tamar, and at Gunnis Lake, Callington. The specimens which have been obtained lately are not so well crystallized as those which were raised formerly, neither do they equal them in colour, being of a pale verdigris-green. Tamarite occurs associated with cuprite, copper pyrites, and malachite.

The name Tamarite is the one proposed by Brooke and Miller for this mineral, but what connexion there may be between the Tamar, or any of the Tamar mines, and the species in question, is by no means obvious.

168. CLINOCLASE.—Klinoclase, *Brooke* and *Miller*; Oblique Prismatic Arseniate of Copper, *Phillips*; Trihedral Arseniate of Copper, *Bournon*; Aphanèse, *Beudant*; Strahlerz, *G. Rose*, *v. Kobell*; Abichit, *Haidinger*; Klinoklas, *Hausmann*. Dark Blue Arseniate of Copper.

Oblique. Rarely occurs distinctly crystallized in small oblique rhombic prisms, whose lateral planes meet alternately at angles of about 56° and 124°, and of which the oblique plane declines from one acute angle to the other. Cleavage basic, very perfect, the planes of cleavage in aggregated forms being curved. Colour, externally, almost blackish blue-green; internally, dark verdigris-green. Streak bluish-green. Lustre pearly on cleavage planes, otherwise vitreous. Fracture uneven. Translucent on the edges, opaque. H. 2·5 to 3; Gr. 4·2 to 4·4.





M' P	95° 00'
M M'	56 00
P *s*	80 30
P *a*	99 30
P *r*	123 48
r a	155 42
s a	161 00
M *a*	118 00

Combinations: P M *s*; P M *r s*; P M *r s a*.

Before the blowpipe it emits arsenical vapours, and fuses readily with deflagration, yielding a bead of copper. Soluble in acids and in ammonia.

Analyses: *a*, by Rammelsberg; *b*, by Damour:—

	a.	*b.*
Oxide of copper . . .	60·00	62·80
Arsenic acid	29·71	27·09
Phosphoric acid . . .	0·64	1·50
Oxide of iron	0·39	0·49
Lime	0·50	. . .
Silica	1·12	. . .
Water	7·64	7·57
	100·00	99·45

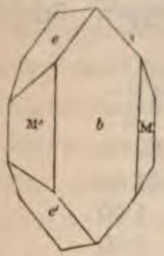
$\dot{\text{C}}\text{u}^3(\ddot{\text{A}}\text{s})+3\dot{\text{C}}\text{u}\dot{\text{H}}$; with oxide of copper, 62·7; arsenic acid, 30·2; water, 7·1.

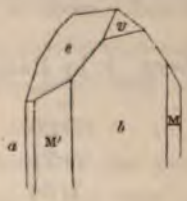
Till recently the British localities of this rare mineral were confined to Cornwall, where it occurred at Ting Tang mine, at Huel Unity, and Wheal Gorland, and a few other mines near St. Day. Distinctly crystallized specimens were scarce, the mineral being usually met with in hemispherical and reniform masses, having a columnar or radiated structure and drusy surface. It has recently been met with in such masses, of a peculiarly rich colour, at Bedford United mines, near Tavistock.

The name is derived from *κλίνω, to incline,* and *κλάω, to break,* in allusion to the oblique cleavage.

169. **OLIVENITE.**—Right prismatic Arseniate of Copper, *Phillips*; Olivénite, *Beudant*; Olivenit, *Haidinger, v. Leonhard, v. Kobell, Naumann.*

Prismatic. Primary form a right rhombic prism. Cleavage M indistinct. Fracture conchoidal, uneven. Leek-green, olive-green, pistacio-green to blackish-green when crystallized; in the fibrous varieties brown, yellow, grey. Streak olive-green to brown or grey. Lustre vitreous to resinous and silky. Brittle. H. 3; Gr. 4·2 to 4·6.





M M'	92° 30'
M *b*	136 15
M *a*	133 45
e e'	69 10
a b	90 00
v b	125 46
e a	124 35

Combinations: M *e*; M *e b*; M *e b a* (*v*). The faces *e*, *a* frequently uneven.

Analyses: *a*, by Kobell; *b* and *c*, by Richardson; *d*, by Hermann; *e*, by Damour, all from Cornwall, and crystallized:—

	a.	*b.*	*c.*	*d.*	*e.*
Oxide of copper .	56·43	56·2	56·65	56·38	56·86
Arsenic acid . .	36·71	39·9	39·80	33·50	34·87
Phosphoric acid .	3·36	...	...	5·96	3·43
Water	3·50	3·9	3·55	4·16	3·72
	100·00	100·0	100·00	100·00	98·88

Formula, $\dot{C}u^3(\overset{\cdot\cdot\cdot\cdot\cdot}{\bar{A}}s,\overset{\cdot\cdot\cdot\cdot\cdot}{\bar{P}})+\dot{C}u\dot{\bar{H}}$ (the arsenic acid to the phosphoric as 5 to 1); with oxide of copper, 57·57; arsenic acid, 34·84; phosphoric acid, 4·32; water, 3·27.

A small portion of the arsenic acid is replaced by phosphoric acid, the quantity of the latter varying from 1 to 6 per cent. Before the blowpipe fuses readily in the forceps to a globule studded with prismatic crystals. On charcoal emits arsenical fumes, and is converted, with deflagration, to a brittle bead of arsenide of copper. Decomposed by a solution of potash, leaving a residue of oxide of copper. Easily soluble in nitric acid. When the solution obtained with caustic potash is neutralized with nitric acid, it yields a brownish-red precipitate of arseniate of oxide of silver, on the addition of a solution of nitrate of silver.

Occurs crystallized, reniform, fibrous and capillary, and also massive. The crystals, which are not often very distinct, are met with either singly or united in druses.

The fibrous and acicular variety, to which, from its markings, the name *wood copper-ore* has been given, is supposed by Hermann not to have precisely the same chemical constitution as the crystallized variety, and the formula that he assigns to it is $\dot{C}u^3\overset{\cdot\cdot\cdot\cdot\cdot}{\bar{A}s}\dot{\bar{H}}^2+3\dot{C}u^4\overset{\cdot\cdot\cdot\cdot\cdot}{\bar{A}s}\dot{\bar{H}}$; this gives, oxide of copper, 54·05; arsenic acid, 41·87; water, 4·08; which agrees well with his analysis.

Analyses: *a*, by Thomson, *b*, by Hermann, both from Cornwall:—

	a.	*b.*
Oxide of copper . .	54·98	51·03
Arsenic acid . . .	40·61	40·50
Phosphoric acid . .	...	1·00
Protoxide of iron . .	...	3·64
Water	4·41	3·83
	100·00	100·00

Localities.—The finest specimens known of olivenite have been found in Cornwall, but not of late years, so that they are now scarce. They occurred principally at Huel Gorland, Ting Tang, Huel Unity, Carharrack and other mines near St. Day. It is found also at Wheal Buller and at Pednandrea, near Redruth. At Tincroft, Illogan. Mr. Richard Talling has lately obtained excellent specimens at the old workings of the Wheal Unity, near St. Day.

Devonshire; recently in fine crystals and acicular at Bedford United mines, near Tavistock.

Cumberland; in small distinct crystals, with malachite, on quartz, at Tyne Head mine, near Alston.

Herefordshire; close upon the borders of Shropshire, at a place about seven miles south of Ludlow, according to Mr. Tennant.

The *wood arseniate of copper*, or fibrous variety of olivenite, is difficult to describe on account of the different appearances which it assumes. It is met with of a brown, green, yellow, greyish and white colour. It is found investing or passing into the crystallized variety. Occasionally pretty hard, with a structure finely and divergingly fibrous, and this is the form in which the character of *wood arseniate* is best observed. Texture sometimes earthy; sometimes it occurs in capillary forms with a silky lustre. When massive, sometimes soft enough to soil the fingers.

This singular variety occurred in very fine specimens at Huel Gorland and Huel Unity, in Gwennap; at Carharrack, St. Day; and at Gunnis Lake, Callington. Amianthiform at Tin Croft, Illogan.

170. CORNWALLITE, *Zippe*.

Amorphous. Fracture conchoidal. Emerald-green passing into dark verdigris-green. H. 4·5; Gr. 4·16.

In the matrass yields water. Before the blowpipe on charcoal emits fumes of arsenic, and yields a bead of copper enveloped in a brittle crust.

Analyses by Lerch:—

	a.	*b.*
Oxide of copper	55·00	54·22
Arsenic acid	29·78	30·65
Phosphoric acid	2·54	1·77
Water	12·68	13·36
	100·00	100·00

Composition: $\dot{C}u^5\ddot{A}s+5\dot{H}$; with oxide of copper, 55·37; arsenic acid, 32·07; water, 12·56.

With respect to saturation, this species therefore occupies precisely a central position between olivenite on the one hand, and clinoclase on the other.

May be occasionally found in small botryoidal or disseminated masses on old specimens of olivenite from Cornwall. It may readily be distinguished from green malachite, for which it might at first sight be taken, by not effervescing in acids. It was distinguished and described a few years ago by Professor Zippe.

171. ERINITE, *Haidinger*.

Occurs in mammillated and concentric crusts, having a crystalline and fibrous structure, presenting rough surfaces, arising from the terminations probably of very minute crystals. H. 4·5 to 5·0; Gr. 4·04.

Lustre almost dull, slightly resinous. Colour fine emerald-green, inclining to verdigris or grass-green. Streak apple-green. Brittle.

Contains, according to Turner,—

Arsenic acid	33·78
Oxide of copper . . .	59·44
Alumina	1·77
Water	5·01
	100·00

$\dot{C}u^5\ddot{A}s+2\dot{H}$; with arsenic acid, 34·7; oxide of copper, 59·9; water, 5·4.

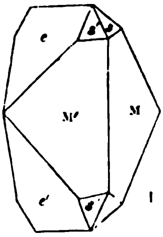
Before the blowpipe emits fumes of arsenic, and melts. Soluble in nitric acid.

Though said to have been found in the Co. of Limerick, this is in all probability a Cornish species; not merely from its close resemblance to the Cornwallite of Zippe, but from the fact of its being accompanied with small crystals of olivenite and aphanesite, and that no specimen of arseniate of copper has yet been noticed in Ireland.

Two specimens only of this rare species have been preserved, of which one is in Mr. Greg's collection.

172. LIBETHENITE.—Phosphate of Copper, *Phillips*; Cuivre Phosphaté, *Dufrénoy*; Libethenit, *Haidinger, Naumann.*

Prismatic. Primary form a right rhombic prism of 92° 20'. From the shortness of the prism and the slight development of its faces, the crystals frequently assume an octahedral appearance. Cleavages imperfect. Fracture conchoidal, uneven. Colour leek-green, olive-green, blackish-green. Streak olive-green. Translucent on the edges. Lustre resinous. Brittle. H. 4; Gr. 3·6 to 3·8.



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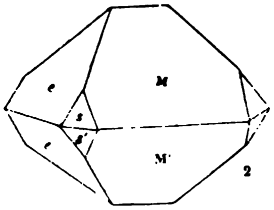


2

e e'	70°	08'
M *s*	135	53
s e	149	06
MM'	92	20
s s'	120	56

Combinations: M *e s*.

Before the blowpipe boils up and fuses readily; on charcoal easily reduced. Dissolves with readiness in nitric acid. Decomposed by solution of caustic potash; the solution, when neutralized with nitric acid, yields a pale yellow precipitate on the addition of a solution of nitrate of silver.

Analysis, by Kühn, of a specimen from Libethen in Hungary, a locality whence the name of the species is derived:—

Oxide of copper . . .	66·94
Phosphoric acid . . .	29·44
Water	4·05
	100·43

$\dot{\mathrm{C}}\mathrm{u}^3\ddot{\overline{\mathrm{P}}} + \dot{\mathrm{C}}\mathrm{u}\dot{\overline{\mathrm{H}}}$; with oxide of copper, 66·5; phosphoric acid, 29·7; water, 3·8.

According to Berzelius, a portion of the phosphoric acid is replaced by arsenic acid. Isomorphous with olivenite. The chemical constitution of these two species is analogous, the latter containing arsenic acid, a small part of which is replaced by phosphoric acid. Figure 1 shows the position with reference to its isomorphism with olivenite; and figure 2 the same form drawn in the usual way. Crystals small, single, or united in druses.

LOCALITIES.—It was formerly found, but not abundantly, in gossan, mixed with quartz and pyrites, at Gunnis Lake, Callington. Mr. Garby has met with it recently, forming crusts of small crystals, in the neighbourhood of Redruth.

173. LUNNITE.—Hydrous Phosphate of Copper, *Phillips*; Cuivre Hydrophosphaté, *Dufrénoy*; Lunnit, *Haidinger*; Phosphorochalcite, *v. Kobell*; Phosphochalcite, *Dana*.

Oblique. Fracture small, conchoidal, or uneven. Semitransparent, translucent on the edges. Lustre vitreous, inclining to adamantine. Green of various shades. Streak verdigris-green. Brittle. H. 4·5 to 5·0; Gr. 4·0 to 4·4.

Decrepitates when heated quickly. Before the blowpipe, when heated slowly, turns black and melts into a black bead containing a globule of copper. When melted with an equal volume of lead, the globule is coated over by a crystalline shell of phosphate of oxide of lead. Moistened with hydrochloric acid, it imparts a blue colour to the flame. Soluble in nitric acid and in ammonia.

Analyses: *a*, by Kühn, from Rheinbreitenbach; *b* (fibrous), by Hermann, from Nischne Tagilsk; *c*, from Cornwall, by Dr. Heddle:—

	a.	*b.*	*c.*
Phosphoric acid . .	21·52	23·75	22·73
Oxide of copper . .	68·74	68·75	68·13
Water	8·64	7·50	8·54
	100·90	100·00	$\ddot{\mathrm{S}}\mathrm{i}$ 0·48
			99·88

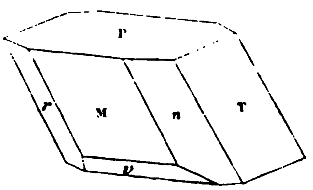
$\dot{\mathrm{C}}\mathrm{u}^3\overset{\cdot\cdot\cdot}{\ddot{\bar{\mathrm{P}}}}+3\dot{\mathrm{C}}\mathrm{u}\dot{\bar{\mathrm{H}}}$; with oxide of copper, 70·9; phosphoric acid, 21·1; water, 8·0.

Only one specimen of this substance has hitherto been found in Great Britain; it is from Cornwall, and in Mr. Greg's collection. Colour verdigris-green, translucent by transmitted light.

Consists of minute globular concretions, not very closely compacted.

174. BLUE VITRIOL.—Sulphate of Copper, *Phillips*; Cuivre Sulfaté, *Hauy*; Cyanose, *Beudant*; Kupfervitriol, *Naumann*, *Hausmann*; Vitriol, *Haidinger*; Chalkanthit, *v. Kobell.*

Anorthic. Primary form a doubly oblique prism. Cleavage M, imperfect. Fracture conchoidal. Semi-transparent, pellucid. Colour Berlin-blue to azure-blue. Streak white. Rather brittle. Taste very repulsive. H. 2·5; Gr. 2·2 to 2·3.



P M	108°	12′
P T	127	31
M T	123	10
M *r*	126	57
M *n*	153	44
M *v*	126	10
P *v*	125	38

Distinct crystals uncommon, usually stalactitic, reniform, and amorphous, or encrusting.

Before the blowpipe, alone, in the closed tube it intumesces considerably, gives off water, and becomes white; when mixed with charcoal in powder it emits sulphurous acid fumes abundantly, upon charcoal especially; if soda is added, it is easily reduced to metallic copper. Readily dissolved in water. The solution deposits metallic copper upon bright iron:—

	Oxide of copper . . .	31·72
$\dot{C}u\dddot{S}+5\dot{H}$	Sulphuric acid	32·14
	Water	36·14
		100·00

Blue vitriol has been found in crystals nearly an inch in length at Ting Tang mine in Gwennap; the crystals were distinct and well defined, though appearing externally to be coated over with impurities. Some of these specimens are preserved, according to Mr. Garby, in the Geological Museum at Plymouth. This species has been met with also at several other of the Gwennap mines. At Trevarthen near Marazion. Crystallized and fibrous, now and then in very good specimens, in the attle-heaps at Gunnis Lake, Callington. Formerly at the Consolidated Mines near St. Day, with copper pyrites.

At Pary's mine, Anglesey.

At various copper mines in Co. of Wicklow.

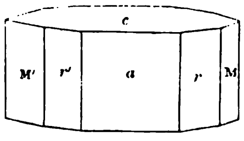
This species owes its existence principally to the decomposition of sulphides of copper, and occurs dissolved in water issuing from mines.

At Pary's mine in Anglesey, strips of iron are laid in the slime containing this salt in solution, when the iron being dissolved, copper is deposited in its place; for every ton of iron consumed there is thrown down a deposit of an equal weight of copper-mud, containing about 12 per cent. of copper. A similar process was followed also at one of the Wicklow mines, where about 500 tons of iron were placed at a time in the cupreous solution. In a year or so the iron bars were dissolved; every ton of iron thus consumed yielded from a ton and a half to two tons of a reddish mud, which consisted principally of the protoxide of copper, and from which 75 per cent. of metallic copper is said to have been obtained. The small bluish-green rhomboidal crystals which are found in the mud at the bottom of an old shaft at the Cronebane copper-mine in Wicklow, contain, according to Mr. Mallet of Dublin, sulphate of copper, 65·7; sulphate of iron, 34·2.

According to Kopp, sulphate of copper is isomorphous with protoxide of manganese and seleniate of oxide of copper.

175. BROCHANTITE.—Brochantit, *Haidinger, Naumann.*

Prismatic. Primary form a right rhombic prism. Cleavage parallel to *a* very perfect, imperfect parallel to M. Fracture conchoidal, scarcely observable. Emerald-green to blackish-green. Streak bright-green. Lustre vitreous. Translucent to transparent. Crystals striated vertically. Brittle. H. 3·5 to 4; Gr. 3·78 to 3·9.



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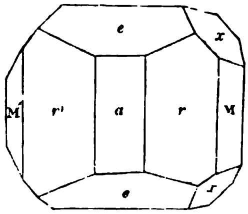

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M *c*	90° 00′	M *a*	127° 55′	*e a*	124° 04′
M M′	75 50	*x c*	127 51	*e e*	28 08
r r′	114 36	*x a*	90 00	*x x*	104 18
r a	147 18				

Combinations: *acr*M; *ar*M*ex*: *c* and *x* new faces; *c* rather rough; *x* probably the face *x* of Levy's Königine.

In the closed tube gives off water and turns black, mixed with charcoal powder emits fumes of sulphurous acid. Before the blowpipe on charcoal fuses, and yields a bead of copper.

With soda produces a hepar. Insoluble in water; soluble in acids.

The analysis by Magnus of a specimen from Rezbanya, in Hungary, gave,—

Oxide of copper	62·63
Oxide of tin	8·18
Oxide of lead	0·03
Sulphuric acid	17·13
Water	11·89
	99·86

$\dot{\mathrm{C}}\mathrm{u}\dddot{\mathrm{S}}+3\dot{\mathrm{C}}\mathrm{u}\dot{\bar{\mathrm{H}}}$; with protoxide of copper, 70·3; sulphuric acid, 17·7; water, 12·0.

In another Hungarian specimen, analysed by Magnus, he found only 3·14 of oxide of tin, but 1·05 of oxide of lead.

Brochantite has been found lately in small but very perfect and brilliant crystals, at Roughten Gill, in Cumberland, on a white quartzose rock, associated with fibrous malachite; its forms are given in the accompanying figures.

It is also reported to have been found once in Cornwall a few years since on decomposed oxide of iron.

The species is named after the French mineralogist, Brochant de Villiers.

176. CHRYSOCOLLA. — Chrysocolla, *Phillips*, *Haidinger*; Cuivre Hydro-silicieux, *Hauy*; Kieselmalachite, *Hausmann*.

Amorphous. Fracture conchoidal. Opaque, translucent on the edges. Lustre resinous. Colour emerald-green to blue. Streak greenish-white. Slightly brittle. H. 2·0 to 3·0; Gr. 2·1.

When heated gives off water. Before the blowpipe becomes black in the outer flame, and red in the inner, but does not melt. With soda yields metallic copper. Is decomposed in acids, leaving a residue of silica in powder.

Analyses: *a*, from New Jersey, by Bowen; *b*, from Franklin, New Jersey, by Beck; *c*, from Bogoslowsk, by Berthier:—

	a.	*b.*	*c.*
Silica	37·25	40·0	35·0
Oxide of copper . .	45·17	42·6	39·9
Red oxide of iron . .	...	1·4	3·0
Water	17·00	16·0	21·0
	99·42	100·0	98·9

Formula, $\dot{\mathrm{C}}\mathrm{u}^3\dddot{\mathrm{S}}\mathrm{i}^2+6\dot{\bar{\mathrm{H}}}$; with oxide of copper, 45·2; silica, 34·3; water, 20·5 *.

Occurs botryoidal, stalactitic, and reniform; also massive, encrusting, and pseudomorphous.

LOCALITIES.—*England.* Cornwall; very plentifully near the Lizard, with native copper in serpentine. At Huel Edward, St. Just, with Arragonite. At Ting Tang mine, Huels Gorland, Unity, and Muttrell, near St. Day; formerly at Prince George mine in Gwinear.

Cumberland; at Dale Head, Red Gill, Roughten Gill and Carrock End, Caldbeck Fells.

Westmoreland; at Newlands Vale.

Isle of Man; at Brathay Head mines.

Scotland.—At Castle Douglas in Kirkcudbrightshire; at Leadhills in Lanarkshire; and at Airthrie, in the Ochils.

Ireland.—At Audley mine, Co. Cork.

Pseudomorphs after cuprite and euchlore mica have occurred in Cornwall. After cerussite and galena at Leadhills.

177. DOMEYKITE, *Haidinger*; Condurrite, *Faraday*; Weisskupfererz, *Hausmann*; Arsenical Copper Pyrites, *Levy*.

Massive; disseminated. Lustre metallic. Colour tin-white, slightly yellowish, often with a tarnish. Fracture uneven.

---

* The per-centage of water varies a good deal in this mineral.

Also black and soft, soiling the fingers (*Condurrite*) when impure or decomposed. H. 3·0 to 3·5; Gr. 4·5.

Analyses: *a*, from Chili; *b*, from Copiapo, both by Domeyko; *c*, by Rammelsberg (*Condurrite*):—

	a.	*b.*	*c.*
Arsenic . . .	28·36	23·29	18·70
Copper . . .	71·64	70·70	70·51
Impurities . .	...	4·39	0·66
	100·00	98·38	89·87

Formula for Domeykite from Peru, $\text{Ȼu}^3\text{As}^2$; copper, 71·63; arsenic, 28·37.

With the blowpipe fuses easily, giving off fumes of arsenic. Not dissolved in muriatic acid. The *Condurrite* affords in a tube fumes of arsenious acid and water, and with soda and borax yields a globule of copper.

Condurrite is a mixture of Domeykite with red copper-ore and arsenious acid, or arsenite of copper.

Rammelsberg treated one specimen with muriatic acid, and analysed the soluble and insoluble portions separately, obtaining,—

1. Soluble: As, 13·89; Cu, 12·81; S, 2·20; $\dddot{\text{A}}\text{s}$, 3·70; $\dot{\text{Ȼ}}\text{u}$, 62·29; $\dot{\text{Ħ}}$, 5·33.

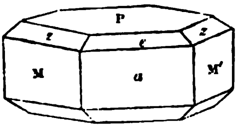
2. Insoluble: As, 13·89; Cu, 4·16; sulphuret of copper, 10·85.

Blyth concludes as a mean of many analyses, that the arseniuret of copper contained in Condurrite consists of arsenic, 28·85, and copper, 71·15. Faraday's analysis (Philosophical Magazine, 1827, p. 286) leads to the same result; or arsenic, 29·89; copper, 70·11.

It occurs mostly in nodular masses, with a flat conchoidal fracture; colour externally brownish-black and earthy; internally, on a fresh surface, it presents a tin-white tarnish. From the Condurrow mine near Camborne, Cornwall; also at the Wheal Druid mine, Carnbrea, near Redruth.

178. CHALCOSINE.—Redruthite, *Brooke* and *Miller*; Cuivre Sulfuré, *Hauy*; Chalcosin, *Beudant*, *v. Kobell*; Kupferglanz, *Haidinger*, *Naumann*; Vitreous Copper, *Phillips*.

Prismatic. Primary form a right rhombic prism. Twins; twin-faces M and *v*. Compound forms frequently stellated. Cleavage indistinct parallel to M. Face P usually striated parallel to the edge between *c* and *d*. Fracture conchoidal to uneven. Very sectile. Blackish lead-grey, lilac and green prevailing; also iridescent. Lustre metallic, dull. Streak more shining. H. 2·5 to 3; Gr. 5·5 to 5·8.



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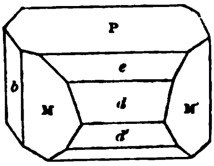

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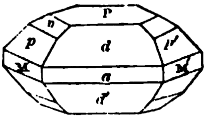

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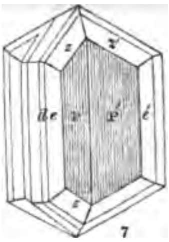

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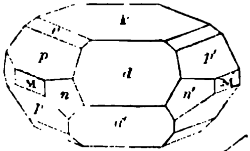

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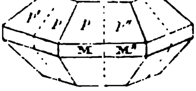

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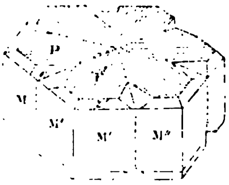

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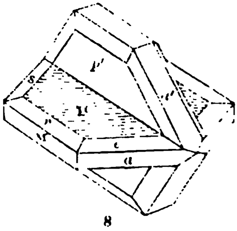


8

P M	90° 00′	P *d*	117° 16′	P *v*	136° 03′	*b p*	140° 07′
M M′	119 35	P *c*	147 06	P *p*	117 24	*p a*	116 32
P *b*	90 00	P *z*	147 16	*d d′*	125 38	M *a*	120 12
P *a*	90 00	*n a*	131 08	*p p*	126 54		

Forms observed in Mr. Turner's and Mr. Greg's collections on Cornish specimens: M P *a*; M *dp*; M P *adp*; M P *b e*; MP*be*, (*d*), (*z*), (*z dp*); M P *z e*; M P *z e a*; M *e a z d*; M P *a b n*; M *a n dp*; M P *a e dp*. The face *n* truncates the edge M *a*.

Before the blowpipe it imparts a bluish colour to the flame; on charcoal in the oxidating flame fuses readily, emitting numerous sparks; in the reducing flame it becomes solid. With soda yields a bead of copper. Is completely decomposed in warm nitric acid, leaving a residue of sulphur.

Analysis by Thomson of a specimen from the United mines, Cornwall:—

Copper	77·16
Iron	1·45
Sulphur	20·62
	99·23

$\acute{\bar{\mathrm{C}}}\mathrm{u}$; with copper, 79·8; sulphur, 20·2.

Occurs in crystals, attached singly or collected in druses; generally, however, massive or disseminated. It is also met with in pseudomorphous crystals exhibiting the faces of the cube and of the octahedron. In figure 7 *two* crystals cross each other at angles of about 56° and 114°; in figure 6 *three* at angles of 60°.

LOCALITIES.—*England*. The finest specimens of vitreous copper have been found in the neighbourhood of St. Just, Cornwall. At Levant it has lately occurred in fine six-sided prisms, as in figures 1 and 6. At Botallack, in hexagonal twin forms like figure 6. At Camborne-vean and at Wheal Crenver. Formerly at Cook's Kitchen, Illogan, in a form which has received the name of nail-headed copper-ore; the same form is said to have been met with at Wheal Abraham, at which latter mine it has occurred recently in thin hexagonal plates with the terminal edges replaced; also arborescent, the individual crystals being long six-sided prisms with flat summits, more or less hollow. At Dolcoath, in Camborne, iridescent. Lately, in fine elongated crystals, very perfect, at Wheal Fanny, and at North Wheal Basset, Illogan. At Wheal Buller, Redruth. It was found massive at Ding Dong, at Wheal Neptune, and in a mine near Tincroft in Illogan.

Said to occur at Middleton Tyas, in Yorkshire; and at Tyne Head, Alston Moor.

Scotland. — Ayrshire; in veins at Fasney Burn in East Lothian; (?) in Fair Isle, between Orkney and Shetlands.

Ireland.—Crystallized and massive in the porphyritic district of Barrack Mountain, in Ulster. Massive at Kenmare mines, Kerry.

The name chalcosine is derived from χαλκὸς, *copper*. It was proposed by Beudant, and has been adopted by v. Kobell, and their authority appears fully to justify its introduction in the place of *vitreous copper*, a term which in many instances by no means describes the mineral correctly. The name Redruthite, proposed by Brooke and Miller, is hardly applicable, as the best specimens do not occur in the mines near Redruth.

179. COVELLINE, *Beudant*; Kupferindig, *Mohs*.

Rhombohedral. Opaque. Lustre resinous, inclining to metallic. Indigo-blue. Streak black, shining. Sectile. In thin leaves flexible. H. 1·5 to 2·0; Gr. 3·80 to 3·82.

Analysis, from Vesuvius, by Covelli:—

Copper	66·0
Sulphur	32·0
	98·0

$\acute{\mathrm{C}}\mathrm{u}$; copper, 66·44; sulphur, 33·56.

Before the blowpipe burns with a blue flame. Melts with ebullition into a globule, which, with soda, yields a bead of copper. Soluble in nitric acid.

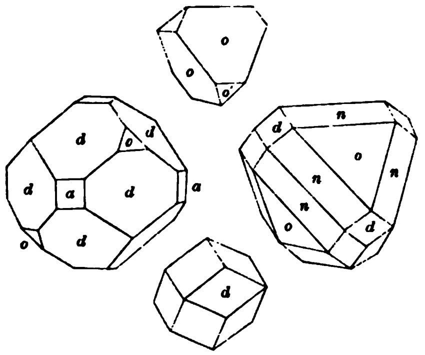
Has occurred lately, investing copper pyrites, accompanied with garnet and brown jasper, at Wheal Maudlin. Perhaps formerly at Huel Kind, near St. Agnes.

180. TENNANTITE.—Tennantite, *Phillips*, *Brooke* and *Miller*; Tennantit, *Haidinger*, *Naumann*.

Cubic. Twins. Twin-face *o*; *n* and *o* hemihedral, with inclined faces. The forms and combinations similar to those of tetrahedrite, as also the twins *d*, striated. Cleavage parallel to *d*, very imperfect. Blackish lead-grey to iron-black. Streak dark reddish-grey. Brittle. Lustre metallic. Opaque. H. 4; Gr. 4·3 to 4·5.

Cornish forms: *d*; *od*; *ad*; *nd*; *aod*; *oo′d*; *aod*; *aodn*; all in Mr. Greg's collection.

Decrepitates before the blowpipe, emits arsenical fumes, burns with a blue flame, and fuses to a magnetic slag.



o o	70°	32′
o o′	109	28
a a	90	00
d d	120	00
o a	125	16
o d	144	44
a d	135	00
n a	144	44
n d	150	00

Analyses: *a*, by Kudernatsch, from Cornwall; *b*, by Phillips, from Cornwall:—

		a.	*b.*
	Copper .	48·94	47·70
	Iron . .	3·57	9·75
	Arsenic .	19·10	12·46
$(\overset{\prime}{\mathrm{R}}{}^4+\overset{\prime}{\mathrm{Cu}}{}^4)\overset{\prime\prime\prime}{\mathrm{As}}$	Sulphur .	27·76	30·25
	Silver. .	trace	...
	Quartz .	0·08	...
		99·45	100·16

In the above formula $4R=3Cu+Fe$, so that the composition of this species is analogous to that of tetrahedrite, of which it may indeed be considered as a pure arsenical variety, requiring,—

Copper	49
Iron	4
Arsenic	19
Sulphur	28
	100

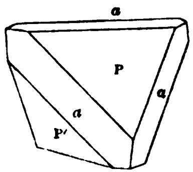
Occurs in small attached crystals, the prevailing forms of which are combinations of the cube, tetrahedron and dodecadron, the faces of the latter usually predominating, rarely massive, with other ores of copper, at various mines in the vicinity, for the most part, of Redruth.

At Dolcoath and Roskerne, in Camborne, formerly. At Cook's Kitchen and Tincroft, in Illogan. Fine, at Wheal Jewel, Gwennap, and at Wheal Unity, Gwinear. At Huel Ryan. At Trevascus. It is not known to have occurred recently, unless at East Relistian mine.

The species is named after the chemist, Smithson Tennant.

181. TETRAHEDRITE.—Grey Copper, *Phillips*; Cuivre Gris, *Hauy*; Panabase, *Beudant*; Fahlerz, *Brooke* and *Miller*, *Hausmann*; Tetraedrit, *Haidinger*, *v. Kobell.*

Cubic. Twins; twin-face P. P and *n* hemihedral, with in-



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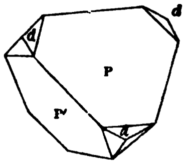

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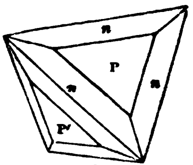


3

a a 90° 00′	P *a* 125° 16′	P *n* 160° 32′
P P 70 32	P *d* 144 44	

clined faces. Cleavage octahedral, imperfect. Fracture conchoidal to fine-grained, uneven. Brittle. Steel-grey to iron-black. Streak black, dark cherry-red in the variety which contains much zinc. H. 3 to 4; Gr. 4·5 to 5·2.

Cornish forms: P *a*; P *d*; P *n*; P *d a*; *n*.

In the open tube yields sulphurous acid, fumes of antimony, and sometimes arsenic. Upon charcoal fuses with slight ebullition to a steel-grey slag, which is usually magnetic, giving with borax a grey metallic bead, which yields with soda a globule of copper. When reduced to powder it is decomposed by nitric acid, nitrous acid being disengaged, and oxide of antimony, sulphur, and frequently arsenious acid separated. Caustic potash decomposes it partially when in powder, dissolving out the sulphides of antimony and of arsenic, which are thrown down of an orange-red or lemon-yellow colour on the addition of an acid.

Analyses: *a*, from Kapnik; *b*, from the St. Wenzel mine near Wolfach, Baden; *c*, from the Habacht mine near Freiberg; *d*, from Markirchen, in Alsace, all by H. Rose:—

	a.	*b.*	*c.*	*d.*
Copper . .	37·98	25·23	14·81	40·60
Silver . . .	0·62	17·71	31·29	0·60
Iron . . .	0·86	3·72	5·98	4·66
Zinc . . .	7·29	3·10	0·99	3·69
Antimony .	23·94	26·63	24·63	12·46
Arsenic . .	2·88	. . .	lead	10·19
Sulphur . .	25·77	23·52	21·17	26·83
	99·34	99·91	98·87	99·03

Analyses: *e*, from Kotterbach, near Iglo in Hungary, by Scheidhauer; *f*, crystallized, from Wheal Prosper, Cornwall, by Wittstein; *g*, from Schwatz, in the Tyrol, by Weidenbusch; *h*, massive, from Poratsch, near Schmölnitz in Hungary, by C. Hauer:—

	e.	f.	g.	h.
Copper	36·94	39·18	34·86	30·58
Mercury	7·73	...	15·70	16·69
Silver	trace	traces	...	0·09
Iron	5·04	6·99	2·26	1·46
Zinc	1·04	traces	1·35	...
Antimony	19·02	23·66	21·53	25·48
Arsenic	4·09	4·40	...	trace
Sulphur	24·00	25·04	23·15	24·37
	97·86	99·27	98·85	100·07

From the above it will be seen how much the composition of tetrahedrite varies. The matter was not indeed at all understood till H. Rose published a masterly article upon the subject, and from an examination and comparison of the numerous analyses contained therein, Gmelin comes to the conclusion that grey coppers may be represented by the general formula $(\overset{\prime}{\dot{\mathrm{R}}}{}^4+\overset{\prime}{\dot{\mathrm{Cu}}}{}^4)\overset{\prime\prime\prime}{\ddot{\mathrm{Q}}}$, in which Q represents in part arsenic, in part antimony, while R represents not only iron, copper and zinc, but also frequently a certain quantity of silver, and sometimes of mercury. In those varieties too which are very rich in silver, it would appear that a part of the $\overset{\prime}{\dot{\mathrm{Cu}}}$ is replaced by $\dot{\mathrm{Ag}}$, which are well known to be isomorphous. With regard to the proportions of antimony and arsenic, it may be observed that, speaking in a general way, we may assume that the grey varieties contain only arsenic, or at least a preponderating quantity of arsenic, and that the dark varieties contain either a smaller proportion of arsenic, or are altogether without it. Lead is an extremely rare constituent of this species. Further details regarding the composition of this mineral will be found in Rammelsberg's 'Handwörterbuch,' in L. Gmelin's 'Handbuch der Chemie,' 4th edition, vol. iii. p. 461, and in G. Rose's 'Mineralsystem,' p. 58.

This species, which as a British mineral was, till latterly, almost confined to Cornwall, is not often found crystallized there, but usually occurs massive. It was found formerly in large tetrahedral crystals, occasionally measuring 1½ inch along the edge, at Crinnis mine, near St. Austell; the faces of the crystals were rough and dull. In brilliant crystals at the Levant mine near St. Just. At Tresavean and some other Gwennap mines. At Cook's Kitchen in Illogan. At Trenance mine, St. Issy. Lately, at Condurrow, Camborne, in fine brilliant tetrahedral crystals. At South Basset. At Treviskey and Barrier in Gwennap. An argentiferous variety occurs at Tremaine mine and in Austen's Lode, Crinnis Consols. Figures 2 and 3, lately at Wheal Prosper, near Falmouth, where a considerable quantity has been found massive, more or less pure, and worked as an ore. Lately also at Herodsfoot mine, with galena.

At Combe-martin, North Devon.

It has also been found crystallized in North Wales.

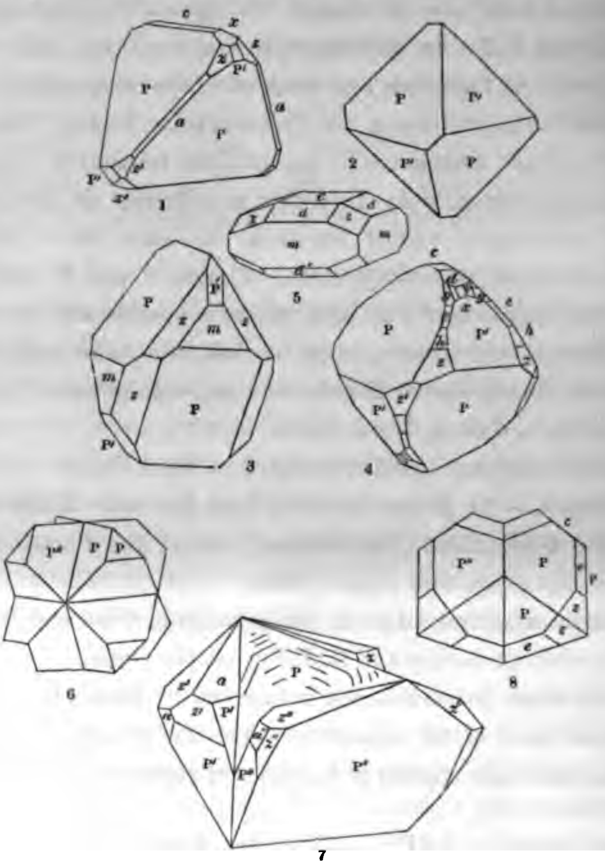
Scotland.—At Fasney Burn, in East Lothian. At Airthrie, in the Ochil Hills. In Mainland, one of the Shetlands, at Sandlodge mine, with copper pyrites.

Lately at several mines in the counties of Cork and Waterford, as at the Audley and Ardtulley copper-mines.

The name *tetrahedrite* was introduced by Haidinger, and is so descriptive of the appearance which the mineral frequently offers, that there appears to be sufficient reason for its adoption.

182. CHALCOPYRITE.—Towanite, *Brooke* and *Miller*; Copper Pyrites, *Phillips*; Cuivre Pyriteux, *Hauy*; Chalcopyrite, *Beudant*; Kupferkies, *Naumann, Hausmann*; Chalcopyrit, *Haidinger, v. Kobell.*

Pyramidal. Frequently hemihedral with inclined planes. Twins. Twin-faces P, *a*, *e*. Cleavage tolerably perfect parallel to *z*. Fracture conchoidal to uneven. *e*, P often striated. Slightly brittle. Brass-yellow, often gold-yellow; when massive very liable to tarnish, the surface being often beautifully variegated with red and purple. Opaque. Lustre metallic. Streak greenish-black. H. 3·5 to 4; Gr. 4·1 to 4·3.



P P'	109° 53'	*a a*	90° 00'	P *e*	144° 20'	*c h*	124° 05'
P *c*	125 40	*c d*	140 47	*g x*	157 09	*c z*	116 54
P *a*	125 03	*c x*	155 05	*g g*	134 19	*z z*	101 50
P *z*	140 20	*v c*	152 33	*c g*	146 42	*v x*	148 06
m a	135 00	*e e*	120 30	*c e*	135 25	*a e*	90 00
m c	90 00						

British combinations: P; P P'; P P' *z*; *c z*; P P' *a*; P P' *c*; P P' *c e z*; P P' *a z*; P P' *a x z*; P *z e*; P P' *c z*; P P' *m z*; *m c d z*; P P' *m z a*; P P' *c d x v g e h z*.

Before the blowpipe fuses readily to a magnetic bead, giving off fumes of sulphurous acid. With lead and borax on charcoal yields a globule of copper. Decomposed by nitromuriatic acid, leaving a residue of sulphur.

Analysis of crystallized chalcopyrite from Cornwall, by R. Phillips :—

Copper	30·15
Iron	32·37
Sulphur	35·34
	97·86

$\overset{\prime}{\not{\mathrm{C}}}\mathrm{u}\overset{\prime\prime\prime}{\not{\mathrm{F}}}\mathrm{e}$; with copper, 34·6 ; iron, 30·5 ; sulphur, 34·9.

According to the analyses of H. Rose, R. Phillips, and Berthier, chalcopyrite consists essentially of 1 equivalent of copper, 1 of iron, and 2 of sulphur, and its composition may consequently be also expressed by the formula $\overset{\prime}{\mathrm{C}}\mathrm{u}+\overset{\prime}{\mathrm{F}}\mathrm{e}$; the former, however, is to be preferred. Either requires about 34·5 copper ; 30·5 iron ; and 35·0 sulphur.

In crystals, usually twins, more or less complicated, and sometimes consisting of three individuals, either attached singly, or united in druses ; more frequently massive and disseminated, sometimes botryoidal and reniform, a variety which is known in Cornwall as *blistered* copper ore. Pseudomorphous, in Cornwall, after blende, tetrahedrite, brown spar, and chalcosine. At some few British localities it contains silver or gold.

The localities of this species are so numerous that it is impossible to cite them all ; the following list may, indeed, perhaps be objected to as entering too much into detail.

Cornwall ; very fine blistered copper, formerly, at Cook's Kitchen, and lately at Wheal Basset ; at East Pool, in perfect tetrahedrons, associated with siderite ; at Carn Brae, disposed on cubes of fluor, in fine iridescent crystals, and also mammillated ; finely crystallized at Tincroft, all in Illogan. At Wheal Buller, near Redruth, in very perfect tetrahedrons an inch and a half long on the edges. In fine crystals at Huel Towan, St. Agnes. At Alfred Consols, near Hayle, in very perfect rhombic dodecahedrons. Finely crystallized, as brown spar, in curved rhomboidal crystals half an inch across, near St. Just. At the Levant mine, St. Just, lately, pseudomorphous, with the form of Fahlerz. At Wheal Fanny, Perran. At Great Crinnis, St. Austell, in the neighbourhood of which town the mines produce the finest iridescent massive variety, known as peacock copper. At North Downs, Redruth. At Herodsfoot near Liskeard. Massive at Trevascus, associated with Cassiterite. In elongated and rounded masses at Cakes and Ale mine. At Huel Unity and Huel Gorland, in Gwennap. At Carharrack near St. Day. At Dolcoath, Camborne. At Trelethra mines. In obtuse rhomboids at Tolgus near Redruth. At Poldice, Gwennap. Massive at Trevascus mine, with tin-ore.

Devonshire; in large tetrahedrons, beautifully iridescent, at Virtuous Lady mine, near Tavistock.

Staffordshire; at the Ecton mine, with the forms *c z*, P P *z*, in transition limestone; and between beds of coal, sparingly, at Wednesbury.

Cumberland; at Hay Gill and Roughten Gill, near Hesket Newmarket, and *auriferous* at Goldscope mine near Keswick. As figure 2, at Alston Moor.

Lancashire; in large quantity at Bole Gap, and finely crystallized, at Coniston United mines, with the form P P′; the face P predominating as in figure 1.

At Dhoon and Laxey, Isle of Man.

In many places in Wales, as at Great Orme's Head, Carnarvonshire; Milford, Pembrokeshire; Prince of Wales mine near Dolgelley, Merionethshire; at Tyns Cynoelin mine, and at Esgair Vraith, Cardiganshire. In large quantity at Pary's mine, Anglesey, formerly. In the neighbourhood of Snowdon in quartz.

Scotland.—At Clifton mine near Tyndrum, Perthshire. At Castle Douglas, and at Cally mine, near Gatehouse, Kirkcudbrightshire. Formerly at Alva in Stirlingshire. In the Shetlands; at Sandlodge mine in Mainland. At Conigsburgh Cliffs. Foliated, at Dunrossness, Fair Isle, between the Shetlands and Orkneys. In small crystals in Prehnite, at the Costorphine Hills near Edinburgh.

Ireland.—At the Cronebane mines; at Ballymurtagh; at Glenmalure in Wicklow. In Mayo; at Sheffry and at Castlebar. Argentiferous, containing 27 ounces of silver to the ton, at Gurtuadyne in Tipperary. In Kerry; at Muckruss near Killarney. In Cork; at Alwin. In Armagh. In Galway. Copper ores have been discovered in seventeen counties in Ireland. The amount of Irish copper ore raised in 1855, and refined at Swansea, was 12,381 tons, producing 1157 tons of pure copper. *Argentiferous* copper pyrites at Gurtuadyne mines, Tipperary.

By far the greater part of the copper produced in the United Kingdom is obtained from copper pyrites. In the year from 30th June, 1852 to 30th June, 1853, there were sold at the ticketings in Cornwall 180,005 tons of copper ores, the yield of which was 11,839 tons of fine copper. A reference to the formula will show that copper pyrites, when pure, contains 34·5 per cent. of copper, whereas the average produce of the above-mentioned quantity of ore was only 6·6 per cent. From the following Table, which is copied from Gryll's 'Annual Mining Sheet,' it will be seen that during the last twenty years the average produce of copper ore sold in Cornwall has never reached 8·5 per cent. The amount of money realized by the sale of copper ores in Cornwall, the produce of the Devonshire mines being also sent to Cornwall for sale, was £1,124,561 for the year ending 30th June 1853. The average price per ton was £6 5*s.*, the average standard £136 16*s.*

Copper Ores sold at the Ticketings in Cornwall from June 30, 1834 *to June* 30, 1855.

Date.	Ore (21 cwts.)	Money.			Produce.	Standard.		
1834	143,296	£887,902	0	0	7¾	£114	4	0
1835	150,617	893,402	15	0	8⅛	106	11	0
1836	140,981	957,752	8	6	8¼	115	12	0
1837	140,753	908,613	15	0	7⅝	119	5	0
1838	145,688	857,779	11	0	7⅞	109	3	0
1839	159,551	932,297	12	6	7¾	110	2	0
1840	147,266	792,758	3	6	7½	108	10	0
1841	135,090	819,949	2	0	7⅜	119	6	0
1842	135,581	822,870	12	0	7¼	120	16	0
1843	144,806	804,445	19	0	7½	110	1	0
1844	152,667	815,246	9	6	7⅜	109	17	0
1845	157,000	835,350	19	6	7¾	103	10	0
1846	158,913	886,785	1	6	7¾	106	8	0
1847	148,674	830,739	9	0	8	163	12	0
1848	155,616	825,080	2	6	8¼	97	7	0
1849	144,983	716,917	7	0	8¼	92	11	0
1850	150,890	814,037	3	0	7¾	103	19	0
1851	154,299	808,244	1	6	7⅞	101	0	0
1852	152,802	828,057	19	6	7⅝	106	12	0
1853	180,095	1,124,561	2	0	6⅜	136	16	0
1854	187,502	1,192,839	9	0				
1855	195,193	1,263,434	17	1				

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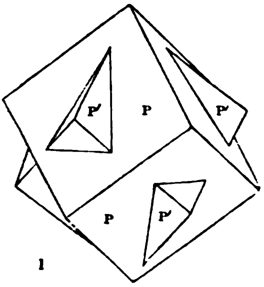
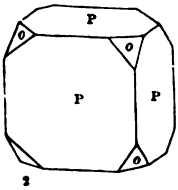
183. **ERUBESCITE.**—Erubescite, *Dana*; Purple Copper, *Phillips*; Bornite, *Brooke* and *Miller*; Horse-flesh Ore. Cuivre Pyriteux Hépatique, *Hauy*; Phillipsite, *Beudant, Dufrénoy*; Buntkupfererz, *Naumann, v. Kobell*; Bornit, *Haidinger*.

Cubic. When crystallized, generally in the form of the cube with the angles replaced. Twins, twin-face *o*. Occasionally the faces of the cube are slightly curved. Cleavage octahedral, very imperfect. Fracture conchoidal to uneven. Colour between copper-red and pinchbeck-brown, but acquires an iridescent tarnish. Streak greyish-black. Somewhat sectile. H. 3; Gr. 4·9 to 5·1.





P P	90° 00′
P *o*	125 16
o o	109 28

Combinations : P ; P *o*. Also P twinned.

Before the blowpipe on charcoal turns black and reddens on cooling, after long exposure to the flame fuses to a brittle magnetic bead of a steel-grey colour externally, but greyish-red on the fracture. With borax and soda yields a globule of copper. In the open tube yields sulphurous acid, but no sublimate. Moistened with hydrochloric acid colours the flame blue. Dissolved partially in concentrated hydrochloric acid, leaving a residue of sulphur.

Analyses by Plattner : *a*, of crystallized erubescite, from Condurrow ; *b*, by Phillips, from Ross Isle, Lake of Killarney ; *c*, of a massive specimen from Sangerhausen ; *d*, by Chodnew, from Redruth :—

	a.	*b.*	*c.*	*d.*
Copper	56·76	61·07	71·00	57·89
Iron	14·84	14·00	6·41	14·94
Sulphur . . .	28·24	23·75	22·58	26·84
	99·84	98·82	99·99	99·67

$\acute{C}u^2+\acute{F}e$; with copper, 62·5 ; iron, 13·8 ; sulphur, 23·7.

The chemical constitution of this mineral is not found by any means to agree in its different varieties. Massive varieties require that to 1 equivalent of iron those of the copper and sulphur should be in the ratio of 4 to 3, or 5 to 4, or 8 to 5, or 9 to 6, and other proportions besides, so that an identity of composition in these varieties is only admissible on the supposition that they contain admixtures of chalcosine or of copper pyrites. The copper varies, it will be observed, from 56 to 71 per cent., and the iron from 6 to 15. In a variety from Monte Catani in Tuscany, Bechi, indeed, found upwards of 18 per cent. of iron.

LOCALITIES.—*England.* This species has been found crystallized in great abundance at Carn Brae, Tincroft, and Cook's Kitchen, in Illogan, to which district it appears to be principally confined. Occurs also at Dolcoath in Camborne, and at Camborne-vean. At Wheal Jewel in Gwennap. At Wheal Falmouth. At South Tolgus, Redruth; at Tincroft near Pool.

Somersetshire; at Broomfield Consols, massive.

Ireland.—Formerly at a mine, now flooded, on Ross Island, Killarney. Fine, at the Kenmare and West of Ireland mines, Kerry. Recently, at the Classadaugh mines, Cork. At the Audley and Ardtulley copper-mines.

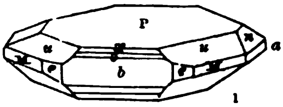
The name erubescite, in allusion to its liability to become tarnished, and thus assuming a reddish hue, was proposed by Dana. In Cornwall it is known to the miners by the name of horse-flesh ore.

184. BOURNONITE.—Bournonite, *Brooke* and *Miller*, *Phillips*, *Beudant*; Antimoine Sulfuré Plombo-cuprifère, *Hauy*; Bournonite, *Haidinger*, *v. Kobell*, *Naumann*; Wheel Ore. Radelerz. Endellionite, *Bournon.*

Prismatic. Primary form a right rhombic prism. Twin-face M. Cleavage indistinct parallel to *a* and to *b*. Fracture uneven to conchoidal. Opaque. Lustre metallic. Steel-grey inclining to lead-grey or to iron-black. Streak the same. Somewhat brittle. H. 2·5 to 3; Gr. 5·7 to 5·9.

Cornish forms: M*ab*P*ou*....*xn*, ...*xne*, ...*yef*, ·*yefn*, ...*yefnx*; also M*b*P*ynx* (*afn*).

ore the blowpipe decrepitates. In the open tube dis-



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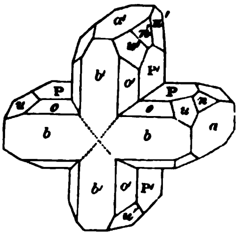

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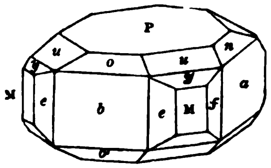


2

M M	93° 40′	P *n*	138° 06′	P *y*	127° 20′
M *b*	136 50	P *x*	154 27	*a b*	90 00
P *a*	90 00	P *o*	136 17	*e f*	118 04
P *b*	90 00	P *u*	146 45	*e b*	154 52

engages sulphurous acid, and gives off white fumes, which deposit a sublimate of oxide of antimony towards the upper part of the tube, and towards the lower part thereof one of antimonite of oxide of lead. Upon charcoal fuses for a while, gives off fumes, and then sets to a black globule, which, on the heat being further urged, yields a sublimate of oxide of lead, and then, on the removal of the lead, produces a globule of copper. Partially soluble in nitric acid, forming a blue solution, and leaving a residue of sulphur and of oxide of antimony. Partially decomposed by nitromuriatic acid, leaving a residue of sulphur, of chloride of lead, and of antimonite of oxide of lead.

Analyses: *a*, from Cornwall, by Smithson; *b*, from Meiseberg, by Bromeis; *c*, from Neudorf, and *d*, from Wolfsberg, both by Rammelsberg:—

	a.	*b.* Gr. 5·70 to 5·79	*c.* Gr. 5·82 to 5·86	*d.* Gr. 5·73 to 5·86.
Antimony . .	25	24·82	24·54	26·08
Lead . . .	41	40·04	41·83	41·92
Copper . .	13	15·16	13·48	12·38
Iron . . .	1	. . .	. . .	. . .
Sulphur . .	20	18·99	20·15	19·62
	100	99·01	100·00	100·00

In *c* and *d* the amount of antimony is deduced from the loss. In some analyses this species is represented as containing from 1 to 2 per cent. of silver, but Rammelsberg, in his fourth 'Supplement,' lays it down as a fact, and the assertion is adopted by Naumann in the third edition of his 'Mineralogy,' that no Bournonite ever contains silver, and that in those cases where silver is met with, its presence is attributable to intermixed argentiferous grey copper.

$\overset{\prime}{\bar{\mathrm{C}}\mathrm{u}}^3\overset{\prime\prime\prime}{\bar{\mathrm{S}}\mathrm{b}}+2\overset{\prime}{\mathrm{P}}\mathrm{b}^3\overset{\prime\prime\prime}{\bar{\mathrm{S}}\mathrm{b}}$ (or $(\overset{\prime}{\mathrm{P}}\mathrm{b}^2,\overset{\prime}{\bar{\mathrm{C}}\mathrm{u}})\ \overset{\prime\prime\prime}{\bar{\mathrm{S}}\mathrm{b}}$); with antimony, 26·0; lead, 41·8; copper, 12·8; sulphur, 19·4.

It is usually associated with antimonite, Jamesonite, galena, chalcopyrite, and siderite. It occurs in crystals, massive and disseminated.

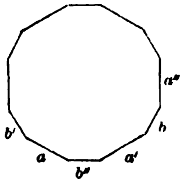
Localities.—*England.* In the United Kingdom this species is not known to have been met with out of Cornwall, in which county it was first noticed in fine crystals, of the form shown by figures 1 and 2 at Huel Boys in the parish of St. Endellion, from which circumstance it was originally called Endellionite by Count Bournon. It is not scarce at mines in that neighbourhood, being frequently found in sufficient quantity to become available as an ore of copper. At St. Merryn near Padstow. At Nanslow near Redruth. Crystallized and compact at Budock Vean near Falmouth. At other mines at Budock Vean, massive. Lately, rather abundantly, at Herodsfoot mine near Liskeard, in compound crystals (*wheel-ore*), like figure 3, and likewise in simple crystals, with the forms M *b* P *o u y n* (*a f*); also massive, or filling hollow crystals of galena, and accompanied with galena, Fahlerz, barytes and hacked quartz.

Ireland.—At Cahirglissawn lead-mine, between Gort and Kenmare, Kerry.

Named after the Count de Bournon.

185. CONNELLITE.—Connellite, *Brooke* and *Miller*, *Dana*; Sulphato-chloride of Copper, *Connell.*

Rhombohedral. Lustre vitreous. Translucent. Smalt-blue to deep Berlin-blue.



a a' 120° 00'
a b' 150 00

The figure gives a section of the crystals.

In the matrass yields a little water. Decrepitates when heated, imparts a fine greenish-blue colour to the flame, and melts before the blowpipe into a dark reddish globule. With soda on charcoal fuses to a slag, which, placed upon a strip of silver and moistened with a drop of water, leaves a brown stain. Completely soluble in nitric and in hydrochloric acid. Insoluble in water.

Consists, according to Connell, of chloride of copper, sulphate of oxide of copper, and a little water.

Occurs in fibrous or small needle crystals and massive, in thin veins traversing the matrix, which in the specimen referred to is earthy cuprite. The colour of the mineral when massive is much darker than when in fibres. Is met with also associated with crystallized cuprite and with an arseniate of oxide of copper.

It is an extremely rare species, and the few specimens of it that are found in collections were discovered, it is believed, many years since. Mr. Rashleigh, in his work on Cornish minerals, speaks of some specimens apparently belonging to the species in question, and he cites Huel Providence as their locality. In Mr. Turner's collection there is a specimen which is stated in the catalogue to be from Carharrack in St. Day.

The Wheal Providence spoken of has been probably long idle, but Carharrack is still in work.

There are several good specimens of this mineral in the collection at the British Museum, but the finest of them is not in the case in which this species is contained.

In old collections in Cornwall, specimens may, not improbably, be found ranged with arseniates of oxide of copper.

Order IX. MOLYBDENUM.

186. MOLYBDINE.—Molybdic Ochre, *Phillips.*

Earthy, opaque, dull. Colour orange-yellow to pale green.

Fusible before the blowpipe. Easily soluble in muriatic acid, and the solution is rendered blue by metallic iron.

Contains,—

Molybdenum	66·5
Oxygen	33·5
	100·0

Formula, $\dddot{\mathrm{M}}\mathrm{o}$.

Localities.—Occurs massive and disseminated on molybdenite, as at Caldbeck Fells in Cumberland.

Scotland.—At Mount Coryby near Loch Creran in Argyleshire; and at East Tulloch, south of Loch Tay, in Perthshire, according to Heddle.

187. MOLYBDENITE, *Haidinger*; Sulphuret of Molybdena, *Phillips.*

Rhombohedral and hexagonal. Commonly foliated or in scales. Cleavage basal and perfect. Opaque. Lead-grey. Streak on paper black, with a decided tinge of green. Lustre metallic. In thin leaves very sectile. Laminæ highly flexible, but not elastic. H. 1 to 1·5, easily impressed by the nail; Gr. 4·4 to 4·8.

Before the blowpipe in the forceps imparts a green colour to the flame; on charcoal sulphurous fumes are emitted, and a white sublimate deposited on the charcoal. In powder is decomposed by nitric acid, leaving a residue of molybdic acid. With hot nitromuriatic acid forms a greenish solution.

Composition :—

Molybdenum	59·13
Sulphur	40·87
	100·00

Formula, $\overset{''}{\mathrm{Mo}}$.

Occurs in the early crystalline rocks, as quartz, granite, gneiss and zircon-syenite.

Localities.—*England.* Cornwall; at Wheal Friendship, Marazion; Huel Mary, in Lelant; at Drakewalls mine near Calstock; in the parish of Gwennap; in old heaps at Huel Gorland, and at Wheal Unity, in St. Day; with chlorite in Gwinear, and at Menabilly, near Fowey.

Cumberland; near Keswick. At Carrock Fells. At Brandygill. In flat hexagonal prisms in granite, near the source of the Caldew, four miles S.W. from Hesket Newmarket. At Calbeck Fell with apatite and mispickel.

In granite, at Shap, Westmoreland.

Scotland.—Argyleshire; crystallized, at Mount Coryby, at the head of Loch Creran. In the Galloway, Dumfriesshire and Wigtonshire Hills. In Perthshire; near Killin, on Lord Breadalbane's estate, and at East Tulloch, west of Ardtalnaig, south of Loch Tay, associated with molybdic ochre and hepatic iron pyrites.

Order X. TUNGSTEN.

188. WOLFRAMINE.—Oxide of Tungsten, *Phillips.* Tungstic-ochre.

Earthy; opaque; dull. Colour pale yellow.

Before the blowpipe on charcoal, in the inner flame becomes blackish-blue, and then black. Soluble in ammonia.

Composition :—

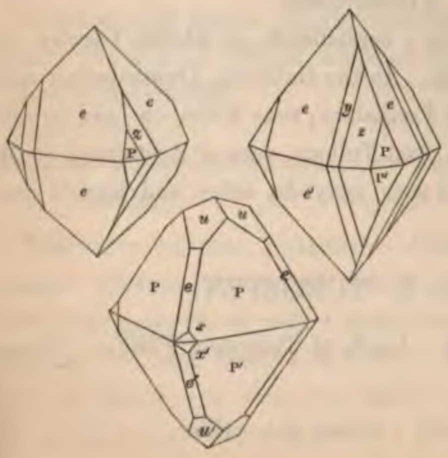
Tungsten	79·84
Oxygen	20·16
	100·00

Formula, $\ddot{W}$.

It is therefore a pure tungstic acid. It occurs investing Wolfram, as at Drakewall tin-mine near Callington; at Huels Friendship and Poldice, in Gwennap, in Cornwall. With Wolfram and Scheelite, at Brandygill, Carrock Fells, Cumberland.

189. SCHEELITE.—Tungstate of Lime, *Phillips*; Schéelin Calcaire, *Hauy*; Scheelit, *Haidinger*, *Hausmann*, *v. Kobell*, *Naumann*; Schwerstein, *v. Leonhard*.

Pyramidal. Primary form a right square prism. Cleavage *e*, P; P more distinct than *e*. The faces *e* striated parallel to their intersections with P and *z*. Fracture conchoidal and uneven. Transparent; semi-transparent to translucent on the edges, and opaque. Lustre vitreous, inclining to adamantine. Face P very brilliant. Colour pale wine-yellow, passing into



P P	100°	40′
P P′	129	02
P *e*	140	10
P *x*	151	34
e e	108	12
e e′	112	02
u u	130	10
u u′	73	08
e x	111	54
e z	157	21
e y	171	30
u u	130	10

grey, yellow, brown. Streak white. Brittle. H. 4·5 to 5; Gr. 5·9 to 6·2. In attached and imbedded crystals. Occasionally massive.

Observed combinations in Cumberland crystals: P*e*; *ez*; *ezx*; P*ez*; P*eux*; P*ezx*; P*exzy*. The face *y* has not been observed before. The forms *z*, *y* and *x* are hemihedral, with parallel faces.

Before the blowpipe melts only with difficulty to a transparent bead. Fuses readily with borax into a clear bead, which, when saturated, becomes milk-white and crystalline on cooling. With salt of phosphorus, in the oxidizing flame, it gives a clear colourless glass; in the reducing flame one which is green while hot, and blue upon cooling. Decomposed by hydrochloric or nitric acid, leaving a residue of tungstic acid. The hydrochloric solution, on the addition of tin and the application of heat, assumes a deep indigo colour. Soluble in caustic potash, leaving a residue of lime.

Analyses: *a*, from Westmanland, by Berzelius; *b*, from Neudorf, near Harzgerode, by Rammelsberg:—

	a.	*b.*
Tungstic acid . .	80·42	78·64
Lime	19·40	21·56
	99·82	100·20

$\dot{Ca}\dddot{W}$. This species is therefore neutral tungstate of lime, the composition of which is tungstic acid, 80·64; lime, 19·36.

Occurs imbedded in chlorite. In attached crystals, associated with tin-ore, Wolfram, apatite, molybdenite and quartz.

LOCALITIES.—Cornwall; formerly in a tin-lode at Pengelley Croft mine, Breage. At Wheal Maudlin, near Lostwithiel.

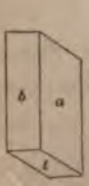
Devon; at Wheal Friendship, near Tavistock, in fine octahedrons of a rich yellow colour imbedded in chlorite, and occasionally associated with Wolfram: now and then the crystals met with at this locality are 1½ inch long.

Cumberland; near Brandygill, Carrock Fells. For form, transparency and colour, the crystals met with at this locality are the finest in the United Kingdom Colour, when transparent, pale wine-yellow, when opaque greyish-brown. These crystals occur in quartz rock associated with Wolfram, and have rarely occurred over an inch in diameter.

The name Scheelite has been given to this mineral in honour of the Swedish chemist, Scheele, who discovered tungstic, or, as it was formerly termed, Scheelic acid in this species. The minerals into which tungstic acid enters as a constituent are remarkable for their high degree of specific gravity.

190. WOLFRAM. — Tungstate of Iron, *Phillips*; Schéelin Ferruginé, *Hauy*; Wolfram, *Hausmann*, *Haidinger*, *v. Kobell*, *Naumann*.

Prismatic. Primary form a right rhombic prism. Cleavage parallel to *a* perfect, to *b* and *u* imperfect. The face *t* often hemihedral. Fracture uneven. Opaque. Lustre brilliant, submetallic. Colour brownish-black. Streak reddish-brown, black: from the colour of the streak the variety rich in manganese is to be distinguished from the variety rich in iron; in the former the streak is brown. Sometimes feebly magnetic. Sometimes twinned. Twin-face *b*. Plane *t* frequently hemihedral. Faces *b* and *t* comparatively large. M striated vertically. Conducts electricity feebly. Brittle. H. 5 to 5·5; Gr. 7·2 to 7·5. The following angles are given by Naumann:—



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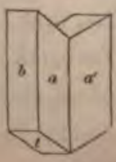

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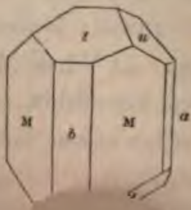


3

M M	101° 05′
M *t*	110 46
b a	90 00
b t	117 20
M *b*	140 32
u u	99 12

Before the blowpipe upon charcoal, exposed to a strong heat, it melts to a magnetic bead, the surface of which on cooling becomes covered with crystals. With borax gives the reaction of iron, with salt of phosphorus, in the reducing flame, that of tungstic acid; with soda, on platina foil, that of manganese. In powder decomposed in hot hydrochloric acid, leaving a yellow residue, which is for the most part soluble in ammonia.

Analyses: *a*, from Lockfells, in Cumberland, by Kerndt; *b*, from Godolphin's Ball, in Cumberland, by Berzelius; *c*, from Godolphin's Ball, by Kerndt:—

	a.	*b.*	*c.*
Tungstic acid	75·96	74·67	75·92
Protoxide of iron	9·54	17·59	19·35
Protoxide of manganese . .	14·50	5·64	4·73
	100·00	97·90	100·00

Formula, $\dot{R}\dddot{W}$; where $\dot{R}$ signifies protoxides of iron and manganese in varying proportions; the formula expressed more specially would be—

For *a*, $3\dot{Mn}\dddot{W}+2\dot{Fe}\dddot{W}$; with protoxide of manganese, 13·88; protoxide of iron, 9·12; tungstic acid, 77·00.

For *b*, $\dot{Mn}\dddot{W}+3\dot{Fe}\dddot{W}$; with protoxide of manganese, 5·80; protoxide of iron, 17·11; tungstic acid, 77·09.

For *c*, $\dot{Mn}\dddot{W}+4\dot{F}\dddot{W}$; with protoxide of manganese, 4·63; protoxide of iron, 18·27; tungstic acid, 77·10.

Is found with oxide of tin, and in quartz rock with apatite and molybdenite. Seldom distinctly crystallized in this country; lamellar, massive. Pseudomorphous after Scheelite; see Wheal Maudlin locality.

LOCALITIES.—*England.* Cornwall; crystallized at Stenna Gwynn near St. Austell. In brilliant crystals at Carnbrae, Illogan. At the same locality also in large rough tabular crystals, imbedded in quartz. Fibro-lamellar and massive at Drake Walls mine near Gunnis Lake. Formerly at Gunnis Lake.

At Kitt's Hill bacillary. In the form of figures 1 and 2, formerly, at Wheal Fanny near Redruth. The form in which this mineral is usually met with in foreign localities is given in figure 3; with us, however, this species, abundant as it is, is seldom met with distinctly crystallized. At Wheal Maudlin, near Lostwithiel, a mineral was met with to which Levy gave the name of *Aikinite*; it is, however, Wolfram in the form of pyramidal Scheelite. Of this interesting pseudomorph only a few specimens were found.

Cumberland; with Scheelite, massive and fibrous, in quartz, at Brandygill, Carrock Fells, at Lockfells, and at Godolphin's Ball.

It is said to have been met with recently in the Isle of Man.

Scotland.—Island of Rona, off Cape Wrath, in granite.

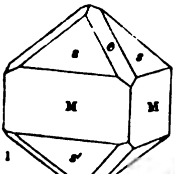
Ireland.—In the auriferous sand of some of the Wicklow rivers, with tin.

Wolfram is very abundant in many of the tin-mines in the west of England, so much so indeed as not unfrequently to render the dressing of the tin-ore a matter of much difficulty. This is partly owing to the specific gravity of the two minerals being so nearly alike. Mr. Oxland of Plymouth has discovered an elegant and simple process for effecting a separation of the Wolfram, which Sir Henry De la Beche, in his lecture on the Uses and Products of the Great Exhibition, describes in the following words:—"After crushing or otherwise pounding the mixed substances, they are roasted, and, the Wolfram still remaining unaffected, after again washing, they are roasted with carbonate of soda, thus decomposing the Wolfram, and tungstate of soda being formed, the tin-ore is then fitted for further treatment in the smelting-house." It has been proposed to employ as a mordant the tungstate of soda obtained from the decomposition of Wolfram.

Order XI. TIN.

191. CASSITERITE.—Cassiterite, *Brooke* and *Miller*; Oxide of Tin, *Phillips*; Etain Oxidé, *Hauy*; Cassitérite, *Beudant*; Zinnerz, *Naumann*; Kassiterit, *Haidinger*, *v. Kobell*.

Pyramidal. Primary form an obtuse octahedron with a square base. Cleavage M, *e* and *a*, but not distinct. Crystals very frequently twinned, or geniculated; two, three or more individuals being united to each other at angles of 112° 10′. The faces *l*, *c*, *k*, *r*, M, *h*, P often rough or uneven; *s*, *e* sometimes striated parallel to their intersections with each other. Twin-face *e*.



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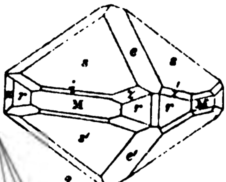
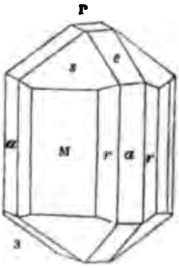

s
e
s
r
M
r
r
M
s'
e'
2



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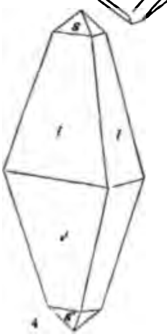

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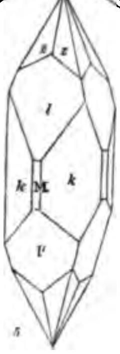

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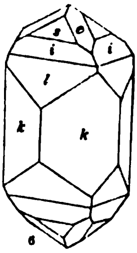

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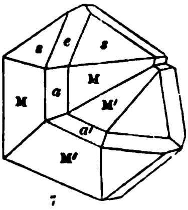

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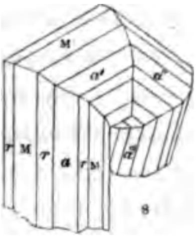
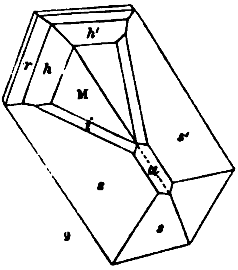

M
a'
a'
r
M
r
a
r
M
a
8



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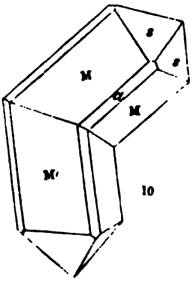

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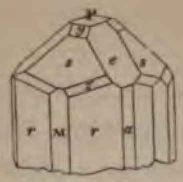


11

		M M	90° 00′	M *r*	168° 41′
		P M	90 00	M *h*	161 34
		a a	90 00	M *a*	135 00
		M *y*	119 43	M *e*	113 15
		M *s*	133 34	M *z*	155 00
		M *i*	157 11	P *z*	112 25
		M *l*	175 10	*z z*	159 06
		M *k*	171 30	*z z′*	118 18
h a	153° 26′	*e e′*	67 50	*s s′*	87 07
e a	123 55	*s s*	121 40	*k k*	163 00

N.B. *h* cuts the edge *r a*; *l* the edge M *i*; and *y*, *l c.*

Combinations: *s*; *s* M; *s e* M; *s a* M; *s e* M P; *s a* M *e*; *s e* M *r a*; *s e* M *a* P; *s e* M *r h*; *s e* M *r a h*; *s e* M *r a* (P), (*h z l i*), (P *z y*), (*i z*), (*z*); also *k z*; *l z*; *l s*; *l i*; *z h*; M *z s*; M *z s h*; M *s l k*; M *k z l*; *k z s e*; *k z s e r*; *s z h*; *k l s i e*.

The above figures and combined forms all represent Cornish crystals.

Fracture imperfect conchoidal to uneven. Semi-transparent to opaque. Sometimes colourless, but generally coloured; yellowish-brown, reddish-brown, clove-brown to blackish-brown and black; yellowish-grey to smoky-grey; seldom yellowish-white to wine-yellow or hyacinth-red. Streak light-grey, in some varieties light-brown. Lustre adamantine to resinous and waxy. H. 6 to 7; Gr. 6·8 to 7.

Before the blowpipe, alone, unchangeable; on charcoal with cyanide of potassium easily reduced to metallic tin; many varieties give with soda on platina foil the reaction of manganese. Is not acted upon by acids. Can only be decomposed by fusion with alkalies. Usually contains some peroxide of iron, which, in the variety known as *wood-tin*, is found to reach 9 per cent.

Analyses: *a*, from Alternon, in Cornwall, by Klaproth; *b*, from Wicklow, by Mallet:—

		a.	*b.*
	Oxide of tin	98·93	95·26
$\ddot{S}n$	Peroxide of iron	0·32	2·41
	Silica	0·75	0·84
		100·00	98·51

In attached and imbedded crystals, and in druses, reniform, botryoidal, fibrous, and granular masses. Pseudomorphous after felspar.

Occurs in veins and beds and disseminated in granite, gneiss, mica-slate, chlorite and clay-slate, accompanied by quartz, Wolfram, fluor, blende, apatite, topaz, &c., and in alluvial deposits.

Localities.—*England.* Cornwall; very fine crystallizations of Cassiterite have been found at mines in the neighbourhood of St. Agnes, as at Polberrow Consols and at Huel Pye. In fine twinned crystals at Beam mine, in St. Roach parish, and other mines near St. Austell. In large macled crystals, like figures 7 and 9, at Wheal Tremayne in Gwinear. Recently, in fine black crystals at Kitt Hill. Prismatic forms, similar to figures 1 and 2, have occurred in the Pell mines in St. Agnes, and at Pednandrea near Redruth. Pyramidal forms, similar to figure 2, at Huel Maudlin near Lostwithiel, and near Camborne at Relistian mine. The most curious and beautiful crystals of tin ore, the most remarkable for the perfection of their form and the multiplicity of their combinations, were met with some years ago at the Wherry mine, near Penzance. Everything connected with this mine was curious: the shaft was not on the mainland, but was sunk through artificial earthworks below high-water mark; and the rock in which the tin ore occurred is a chloritic conglomerate, the nodules of chlorite being, as it were, cemented together with the oxide of tin. It is in the crevices and hollows between the nodules that the crystals alluded to were found. The workings at the Wherry mine have been given up for many years.

Sparable tin, so called from its supposed resemblance to a particular kind of nail termed a sparable, occurs in small, brilliant, pyramidal, or long prismatic crystals, like figures 4 and 5, of a black colour, in Camborne. Fine specimens have been met with quite recently, at Wheal Harris.

It occurs disseminated in granite at St. Michael's Mount, and various other places. Radiated at Huel Park near St. Agnes. In double four-sided pyramids, figure 4, at Huel Owls.

Fibrous tin, or *wood-tin,* contains sometimes as much as 9 per cent. of the peroxide of iron. It occurs in globular or botryoidal masses, or in broken wedge-shaped fragments, usually small, but latterly has been found near Penzance, in walls by the roadside, in fragments "nearly as large as a man's head." The surface water-worn frequently, and often exhibiting that peculiar distribution of colour in superimposed bands of various shades of brown and yellow, from which this variety derives its trivial name.

Structure divergingly fibrous in one direction, concentrically lamellar in the other. Lustre glimmering. Occurs at some of the principal stream-works near Truro, Bodmin, and St. Austell, sometimes in masses of considerable size, also at Roach. At Huel Garth near Penzance. Has been recently met with in the matrix, at Polberrow Consols, St. Agnes, in very fine specimens. A remarkable mammillated variety has occurred very lately, also *in situ,* at Sancreed; it is in the form of thick concretions capping crystals of quartz.

Toad's-eye tin is merely a variety of wood-tin occurring in minute spherical masses with a fibrous structure. Colour light hair-brown. Is found in mines at Tregurthy Moor near St. Austell, imbedded in quartz, as at Gavriggan mine.

Stream-tin, as the name implies, is the alluvial debris of tin-veins separated from the deposit of gravel by washing. Occurs in low marshy grounds in Cornwall, and has been also found in some branches of Falmouth Harbour. Animal and vegetable remains, such as horns and nuts, are occasionally found impregnated with oxide of tin near these so-called stream-works. The stream-tin at Trewarda, Kenwyn, is said to contain gold. At Ladock, near Grampound, of a black colour. Associated occasionally with grains of gold, at Lanlivery, near Lostwithiel. Black at Fore Moors, St. Columb. Reddish-brown at Carnon, Feock parish.

Large pseudomorphous crystals of Cassiterite, after felspar, occurred in considerable abundance at Huel Coates near St. Agnes. Many of these crystals presented the curious circumstance of showing the original felspar replaced by oxide of tin only about half across longitudinally. It is principally in flat and long crystals that this is to be observed: in the stout crystals the substitution of the oxide of tin for the felspar is far more complete; lately, these pseudo-crystals have been noticed by Captain Puckey of Fowey Consols mine at Carn Brecon, St. Mewan, near St. Austell.

Devonshire; at Rix Hill near Tavistock in dark-coloured crystals. At Yeoland Consols, Buckland Monachorum; at Huel Sidney, Plympton.

Tin ore is found in the Isle of Man.

Ireland.—Mr. Mallet has found tin ore in small rolled fragments and detached worn crystals in the sands of the rivers in Wicklow near Croghan Kinshela Mountain.

What is termed in Cornwall *Jew's tin,* is the metal still occasionally met with on the site of old melting-houses, or at least in their neighbourhood; it is usually found associated with charcoal in circumstances which place its artificial origin beyond a doubt. It has been sometimes met with at a considerable depth from the surface, it is true, but the soil in which it has been found is, from its nature, liable to be affected considerably by the influence of local actions, either temporary or permanent. Thus there is no reason whatever to doubt that the two blocks of Jew's tin, which each weighed 26 pounds, and both of which were met with near St. Austell at the depth of 80 feet below the surface, are an artificial production.

Oxide of tin is the ore from which the whole of the tin used in commerce and the arts is obtained; indeed, it may be said to be the only ore of this metal worked, tin pyrites being found only in such small quantity that, although it contains 25·65 per cent. of metallic tin, as an ore of tin, it is of no value commercially.

The total quantity of tin ore (black tin) raised in Cornwall and Devonshire, from January to December inclusive, in 1855, was 8947 tons; of this quantity Devonshire produced about 320 tons. The average price of the ore per ton was £68, making the actual value of ore sold £608,396. This tin ore was the produce of tin mines and tin stream-works in the two tin-producing counties—the tin mines, &c. of Cornwall numbering 129, and those of Devonshire 27.

The average price of metallic white tin is about £120 per ton.

192. STANNINE, *Haidinger*; Sulphuret of Tin, *Phillips*; Etain Sulfuré, *Hauy*; Zinnkies, *Hausmann*. Bell-metal Ore.

Cubic. Cleavage indistinct parallel to the faces of the cube and dodecahedron. Fracture uneven, or slightly conchoidal. Streak blackish. Colour, when pure, steel-grey, but frequently yellowish from intermixture of copper pyrites. Brittle. H. 4·0; Gr. 4·4.

In the open tube yields white fumes and sulphurous acid. Before the blowpipe on charcoal melts, and the sulphur is given off; the charcoal is covered with the oxide of tin in the form of a white sublimate. With borax yields a scarcely malleable bead of copper.

Analyses: *a*, from Huel Rock, by Klaproth; *b*, by Kudernatch; *c*, from Zinnwald, by Rammelsberg; *d*, from St. Michael's Mount, by Johnston:—

	a.	*b.*	*c.*	*d.*
Copper . . .	30·0	29·69	26·31	23·55
Iron	12·0	12·57	6·80	4·79
Zinc	...	1·79	6·93 (Pb 0·41)	10·11
Tin.	26·5	25·81	28·94	31·62
Sulphur . . .	30·5	29·95	29·89	29·93
	99·0	99·81	99·28	100·00

Formula, $\overset{\prime}{F}e^2\overset{\prime\prime}{S}n+\overset{\prime}{\text{Ȼ}}u^2\overset{\prime\prime}{S}n$; with tin, 27·47; copper, 29·58; iron, 13·07; sulphur, 29·88; but 1 equivalent of the iron frequently replaced by zinc; sometimes also part of the copper.

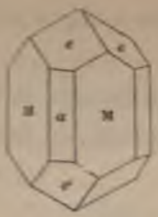
Localities.—*England.* Cornwall; formerly at Huel Rock, St. Agnes. More recently, in considerable quantity, at the Carn Brae mines, where it is sold simply as an ore of copper; also at St. Michael's Mount, in small granite veins; at Stenna Gwynn, St. Stevens; Wheal Primrose; Wheal Scorrier, Gwennap; and occasionally at Botallack mine, St. Just.

Ireland.—In small quantity, it is said to occur at the Cronebane mines, Co. Wicklow.

Order XII. TITANIUM.

193. RUTILE.—Rutile, *Phillips*; Titane Oxidé, *Hauy*.

Pyramidal. Primary form a right square prism. Fracture conchoidal or uneven. Translucent, opaque. Lustre brilliant, inclining to metallic. Cleavage parallel to M and *a* imperfect. Colour reddish-brown to red. Streak light-brown. Twin-face *e*. H. 6·3; Gr. 4·26.



M	M	90°	00′
M	*a*	135	00
h	*a*	153	26
l	*a*	161	34
e	*a*	122	47
e	*e*	134	58

The faces *h* and *l* cut the edge M *a*. Scotch forms: M *a e*, M *a e h l*.

Before the blowpipe infusible; with borax yields a greenish glass in the outer flame, and a dirty violet glass in the inner flame.

Analyses: *a*, by A. Demoly; *b*, from St. Yrieux, by H. Rose:—

	a.	*b*.
Titanic acid	96·41	98·5
Red oxide of iron . .	1·63	1·5
Oxide of manganese .	0·13	...
Silica	1·83	...
	100·00	100·00

Formula, $\ddot{Ti}$.

Localities.—*England*. In the cavities of argillaceous ironstones, occasionally near Aberdare and Merthyr-Tydvil in Glamorganshire.

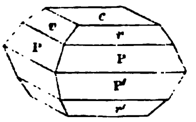
Scotland.—Fifeshire; in quartz. Argyleshire; at Glen Finnart. Perthshire; at Crianlarick, in large striated prisms, occasionally terminated as in the figure, and in fibrous masses; on Ben-y-gloe; near Killin, in calcite and quartz, at Craig Calleach; in limestone at Rannock. Rarely, well crystallized with the prismatic faces M *h l* at Hillswick, Shetlands; also in Burra Isle.

Ireland.—Co. Donegal; at Malin Beg, in white crystalline quartz, in large prisms; at the junction of the magnesian limestone and quartz, in small crystals, near Dunfanaghy.

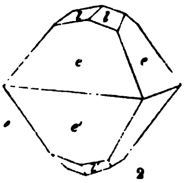
The name *rutile* is derived from the Latin *rutilus*, signifying *shining red*.

194. ANATASE, *Phillips*; Anatas, *Haidinger*.

Pyramidal. Primary form an octahedron with a square base. Cleavage parallel to P and *c* readily obtained. Fracture conchoidal. Translucent to opaque. Lustre adamantine, inclining to metallic. Colour clove-brown, indigo-blue, black. Streak white. Brittle. H. 5·5; Gr. 3·82.



1



2

c l	166° 16′
c v	160 15
c r	153 19
c z	149 22
c x	134 28
c y	130 29
c P	111 42
c M	90 00

m m	90° 00′	P *e*	138° 56′	*e e*	116° 43′
P P	97 51	*c e*	119 23	*l e*	139 50
P P′	136 30	*e e′*	121 16	*l l*	159 26

British forms: *c* P; *c* P *v*; *e l*; *c m* P *y x z r v l*. The faces *c*, *l*, *v*, *r*, *z*, *x*, *y*, P or *y*, P, M, in one zone.

Phosphoresces suddenly when heated before the blowpipe. Infusible. With salt of phosphorus fuses with difficulty, giving in the reducing-flame a blue or violet bead when tin is added. In the form of powder, with soda, fuses with effervescence to an opaque crystalline bead, which is dark-brown or blackish while hot, but becomes greyish-white on cooling. Not acted upon by acids.

	Titanium	60·29
$\ddot{\mathrm{Ti}}$	Oxygen	39·71
		100·00

Localities.—*England.* It occurs in Cornwall at Looe Mills Hill quarry, half a mile from Liskeard, and at Tintagel Cliffs, associated at the latter locality with crystals of quartz and adularia.

Devonshire; at Virtuous Lady mine, near Tavistock, in very perfect and distinct crystals (figure 1), from $\frac{1}{16}$th to $\frac{1}{8}$th of an inch in diameter, engaged in chlorite. Good specimens have been met with recently, showing the forms P *c*, P *v c*; Mr. Brooke however, has a crystal from this locality with the form *c l v r z* *y* P *m*; the faces *x y* not before observed, and for the measurements of which the Authors are indebted to Mr. Brooke.

Occasionally in good-sized crystals, but usually small, with Brookite and Cleavelandite, at Tremadoc, Snowdon. A crystal from this locality has the form of figure 2; the faces *l* seem not to have been before described.

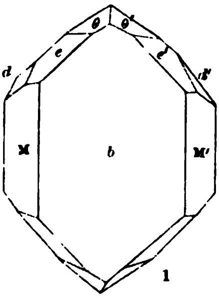
The copper-red cubic crystals found in the hearths of iron furnaces near Glasgow, and at Merthyr-Tydvil in Glamorganshire, at Bromford in Staffordshire, and elsewhere, and su posed by Dr. Wollaston to be metallic titanium, have be shown by Professor Wöhler to consist of titanium, 78·00; n trogen, 18·11; carbon, 3·89; which composition leads to t formula $TiCy+3Ti^3N$. If these crystals are heated in a tu through which a current of steam is passed, they are convert into an aggregation of crystals of anatase. These cubic cryst are doubtless derived from the titanic crystals which occur the balls of clay ironstone.

Note.—The face *l* has been since noticed by Dauber (Po xciv. 407), he giving for *l l* the angle 159° 58′. Dauber a mentions the occurrence of the pyramid $\frac{5}{7}$, in a crystal fr Tavistock.

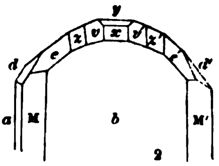
195. BROOKITE, *Phillips*.

Prismatic. Primary form a right rhombic prism. Cleava parallel to *a*. Fracture conchoidal, uneven. Lustre adama tine, inclining to metallic. Translucent to opaque. Col reddish or yellowish-brown, hyacinth-red. Streak yellowi white. Brittle. H. 6 to 6·5; Gr. 3·85 to 4·22.

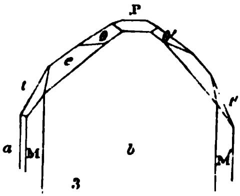
Infusible alone before the blowpipe. If, when reduced fine powder, it is fused with potash and then dissolved in hyd chloric acid, the solution, on being boiled with metallic tin, sumes a violet colour, which is converted to red on being diluted with water, and this colour undergoes no further change.



1


y
z
v
x
v′
z′
e
e′
d
d′
a
M
b
M′

2


P
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θ′
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t′
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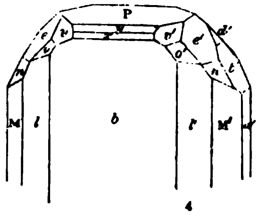
M
b
M

3


P
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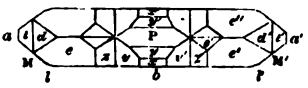
4


a
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d′
t′
a′
e′
M′
l′

M P	90° 00′	*t t′*	55° 48′	*b z*	116° 54′	*b h*	103° 05′
M M	99 50	*y y*	148 40	*b v*	118 10	*f b*	109 14
M *b*	139 55	*x x*	121 14	*b r*	136 24	*f a*	157 29
l b	157 11	*b e*	112 12	*b u*	132 35	*w b*	108 00
k b	168 07	*b θ*	104 06	*b i*	128 13	P *x*	150 32
M *a*	90 00	*b o*	129 13	*b n*	117 32	P *y*	164 20
d d′	76 55						

Forms observed by Mr. Greg in crystals from Tremadoc: M*bdeθ*; M*beθh*; M*aldteθ*; M*bl*P*xdtei*; M*bldtae θrunw*; M*abxe*(*θ*), (*ldtvz*), (*ydtθvzo*), (*ldtθif*), (*lcydtθv*); M*bdeθ* (*v*), (*vz*), (P*vz*), (*l*P*yxtzri*), (*lvn*), (*ltri*), (*lytzoin*), (*l*P*yxtz*) and (*l*P*yxtvzoin*).

The faces *b l* usually striated parallel to their intersections with M. *θ* often dull or uneven. The faces *i, w, k, r, h, u* are rare.

Mr. Brooke observed the faces *k*, *w* in Tremadoc crystals; *r*, *u*, *i* replace the edge *b n*; *k* the edge *l b*.

Analyses: *a*, by H. Rose; *b*, from gold-washings between Slatoust and Miask, in the Ural, by Hermann:—

	a.	*b.*
Titanic acid	89·59	94·09
Peroxide of iron . .	1·41	4·50
Alumina	...	trace
Loss by ignition . .	...	1·41
$\ddot{T}i$	100·00	100·00

Magnificent crystals of this mineral, associated with albite and sometimes with anatase, have occurred engaged in a white quartz rock at Fronolen, on the road from Bedgellert to Snowdon, near Tremadoc, in Carnarvonshire. They are occasionally an inch in length, and nearly as much in diameter.

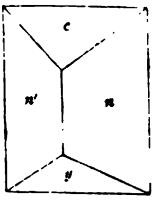
Brookite has also been found in microscopic crystals imbedded in siderite, accompanying the chlorite in which anatase occurs, at Virtuous Lady mine, Tavistock; and rarely in small crystals on titanic iron, at Craig Cailleach, Perthshire.

Very elaborate figures and measurements of this mineral are given in the recent work of Brooke and Miller.

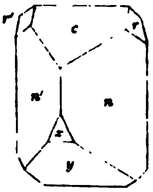
Titanic acid is dimetric, being pyramidal in rutile and anatase, and prismatic in the present species.

196. SPHENE.—Sphene, *Brooke* and *Miller*, *Phillips*; Titane Calcaréo-silicieux, *Hauy*; Sphène, *Beudant*; Sphen, *Haidinger*, *v. Kobell*; Titanit, *Naumann*.

Oblique. Primary form an oblique rhombic prism of 76° 01′ and 103° 59′. Cleavage indistinct. Fracture imperfect, conchoidal. Transparent to translucent on the edges. Colour yellow, hair-brown, reddish-brown. Lustre adamantine, inclining to vitreous. Streak white. H. 5 to 5·5; Gr. 3·4 to 3·6.



1



2

n n' 136° 04′ *c n* 145° 25′ (144° 53′) Naumann.
c x 140 39 *c y* 120 30 (119 33) do.
c r 146 44

The forms *cny*; *cnyx*; *cnyr*; *cnyxr*, at New Abbey, near Criffel.

Before the blowpipe melts tolerably easily, with slight intumescence, to a black glass. Decomposed, for the most part imperfectly, by concentrated hydrochloric acid; the solution, when boiled with metallic tin, assumes gradually a violet colour. Decomposed by sulphuric acid, gypsum being formed.

Analyses: *a*, from Schwarzenstein, in the Tyrol, by Fuchs; *b*, from St. Marcel, in Piedmont, by Marignac:—

	a.	*b.*
Titanic acid	43·21	38·57
Lime	24·18	27·65
Protoxide of iron . . .	...	0·76
Protoxide of manganese .	...	0·76
Silica	32·52	32·26
	99·91	100·01

$\dot{Ca}^3\dddot{Si}+\ddot{Ti}^3\dddot{Si}$; with titanic acid, 41·33; lime, 28·22; silica, 30·45.

If, with Gmelin, we express silica by $\dddot{Si}$, the formula would become $\dot{Ca}\dddot{Si}^2+\dot{Ca}\ddot{Ti}^2$.

Localities.—In the United Kingdom sphene is a rare mineral.

Scotland.—It occurs in small crystals of a hair-brown or reddish-brown colour, of the first form represented in the figures, in the syenite of Strontian. At King's House and at Inverary, in Argyleshire. Similarly in the Criffel Hills, Galloway. In distinct crystals, in felspathic granite, with small crystals of Allanite, in a glen a mile west of New Abbey, near Criffel; found there by Dr. Heddle and Mr. Dudgeon in the above forms. On the south side of Loch Ness, Ben Nevis and Culloden, in Inverness. At Freeburn and Aviemore, in Elgin. In several of the Shetlands, as near Loch Triesta, in Fetlar, and at Altaness, in the Island of Burray, in gneiss. At Craig Cailleach, near Killin, in Perthshire, decomposed and of a yellowish colour, along with rutile.

Though generally met with in gneiss or syenite, it is found in small yellowish crystals in chlorite at Virtuous Lady mine, near Tavistock.

Occasionally in small crystals, with Brookite, at Fronolen, near Tremadoc, in North Wales.

Ireland.—In mica-slate, at Carriglinneen, and in small crystals in syenite, at Crow Hill, near Newry, Co. Down.

The name for this species is derived from *σφὴν, a wedge.*

Order XIII. ARSENIC.

197. ARSENIC.—Native Arsenic. *'Αρσενικόν.*

Rhombohedral. Cleavage basal, imperfect. Rarely crystallized. Often granular, massive, sometimes reticulated, botryoidal and stalactitic. Lustre nearly metallic. Colour and streak tin-white, tarnishing soon to dark-grey. Fracture uneven and fine granular. H. 3·5; Gr. 5·93.

Volatilizes in white fumes before the blowpipe, giving the odour of garlic; heated only to redness it burns with a pale bluish flame.

Composition, As; usually with some antimony, iron, bismuth, or cobalt. Oxidizes on exposure.

Said to occur at Dolcoath, near Camborne, in Cornwall, along th cobalt and bismuth ores. Arsenic is now manufactured in gland from arsenical ores of iron and cobalt, and a consider-le amount of arsenic has lately been obtained from the tin es of Pednandrea mine, near Redruth, probably mechanically ixed with them; about 1500 tons of English production were ld in 1856.

The following statistics are taken from Hogg's 'Business lan's Note-Book' for 1857:—

"The difficulty of ascertaining the actual quantity of arsenic roduced from our mines annually is great. This arises from e circumstance that much arsenic is sold from the 'Burning ouses' as white oxide of arsenic, while some mines sell ar-nical iron ores (*Arsenical Mundic*) in small parcels, which are turned as arsenic.

"The produce, however, of white oxide of arsenic, for 1855, Cornwall, has been computed as carefully as possible to be 390 tons.

"The following mines only have furnished exact returns:—

	Arsenical Mundic Tons	White Arsenic Tons
Okel Tor, Calstock	151	...
Bedford United, Tavistock	197	...
Borringdon Consols, Plympton	147	...
Dolcoath Consols, Camborne	...	102
Huel Unity Consols, Gwinear	...	106
Carn Brea Consols, Redruth	...	140
East Pool Consols, Redruth	...	84
Huel Sydney, Plympton	...	11."

8. ARSENITE.—Arsenite, *Brooke* and *Miller*; Oxide of Arsenic, *Phillips*; Arsenic Oxidé, *Hauy*; Arsenikblüthe, *Hausmann*; Arsenige Säure, *Naumann*; Arsenit, *Haidinger*.

Cubic. Usually in crystalline crusts or in capillary crystals and flakes, commonly investing ores of arsenic or cobalt, also massive and earthy. Lustre vitreous, but seldom recognizable. Cleavage octahedral. Fracture conchoidal. Transparent to opaque. White; yellow or red when mixed with realgar. Streak white. Taste sweet and astringent. *Very poisonous.* H. 1·5, according to Breithaupt 3; Gr. 3·6 to 3·7.

Before the blowpipe in the matrass sublimes in minute octahedrons. Is reduced on charcoal when a little moistened soda is added to it, and is volatilized with the smell of garlic. Difficultly soluble in water; the solution on the addition of sulphuretted hydrogen becomes yellow, and throws down a yellow precipitate on the further addition of hydrochloric acid; with hydrochloric acid alone it leaves a grey metallic coating upon a strip of copper.

When pure, arsenite consists of,—

	Arsenious acid	75·81
$\bar{A}s$	Oxygen	24·19
		100·00

Occurs in acicular crystals, filling cavities in masses of arsenical cobalt, at Huel Sparnon, and occasionally investing ores of cobalt at other localities.

Order XIV. ANTIMONY.

199. **KERMES**, *Haidinger*; Red Antimony, *Phillips*; Antimoine Oxidé Sulphuré, *Hauy*.

Oblique. Crystals usually elongated or capillary; faintly translucent. Lustre adamantine, inclining to metallic. Cherry-red. Streak the same. Sectile. In thin leaves, slightly flexible. H. 1·5; Gr. 4·5 to 4·6.

Melts before the blowpipe and emits fumes, depositing a sublimate of oxide of antimony on the charcoal. Soluble in hydrochloric acid with evolution of hydrosulphuric acid. In powder becomes yellow, and is completely dissolved in caustic potash.

Analysis by Rose :—

	a.	*b.*
Antimony	74·45	...
Oxygen	5·29	...
Sulphur	...	20·49

$\dddot{\bar{S}}b\overset{\prime\prime\prime}{\bar{S}}b^2$; antimony, 76·25; oxygen, 4·73; sulphur, 19·02: or oxide of antimony, 30·14; sulphuret of antimony, 69·86.

Occurs usually in fine diverging or interlaced acicular crystals.

Dr. Heddle has a specimen from New Cumnock, in Ayrshire, where it rarely occurs with grey antimony, of a dark cherry-red colour, and in capillary fibres.

200. CERVANTITE.—Cervantite, *Dana*. Antimonoxid. Antimony Ochre (in part), *Phillips*; Antimonblüthe. Weissspiessglanzerz, *Rammelsberg*.

In acicular crystallizations. Also massive as a crust or a powder. Fracture earthy. Opaque, dull, sometimes greasy. Colour Isabella-yellow, sulphur-yellow and white. Streak yellowish-white, glimmering. Soft and friable. Gr. 4·048.

Before the blowpipe infusible, but volatilizes in white fumes; on charcoal reduced, imparting a green tinge to the flame. In the matrass wholly sublimed. Easily soluble in hydrochloric acid, the solution partially precipitated on the addition of water.

Analyses: *a*, by Dufrenoy; *b*, by Bechi, from Pereta, Tuscany; *c*, by Suckow, from Wolfach :—

	a.	*b.*		*c.*
Antimony . . .	67·50	78·83		6·3
Oxygen	16·85	19·47	Oxide of antimony	91·7
Iron	...	1·25		...
Peroxide of iron .	1·50	...		1·2
Carbonate of lime .	11·45	...		...
Insoluble . . .	2·70	0·75		0·8
	99·80	100·30		100·0

Formula, $\dddot{\bar{S}}b+\overset{\cdot\cdot}{\dddot{\bar{S}}}b$; with oxygen, 19·9, antimony, 80·1. Rammelsberg and A. Rose, however, hold that the oxidation is no higher than $\dddot{Sb}$; with oxygen, 15·68; antimony, 84·32; and quotes analysis *c* in corroboration of this, where 6·3 per cent. of antimony are unoxidixed.

Occurs massive and disseminated, or coating ores of antimony (as antimony-glance), to the decomposition of which it owes its origin.

Localities.—*England.* Cornwall; at one mile from St. Minvers, and at Huel Lea, on the Tamar. At Huel Kine; also, it is said, at Huel Boys near Padstow, and near Port Isaac.

Scotland.—At Hare Hill, New Cumnock, Ayrshire; in fine specimens, in cavities of antimony-glance.

201. STIBLITE.—Stiblite, *Blum*; Antimony Ochre (in part), *Phillips*; Stibiconise, *Beudant*; Antimon-Ochre. Spiessglanzocker, *Hausmann.*

Amorphous. Fracture earthy, uneven. Opaque, dull. Colour yellowish. Streak yellowish-white, glimmering. H. 5·5; Gr. 5·28.

In the matrass yields water. Before the blowpipe on charcoal is volatilized, depositing a white sublimate, and leaving a small scoria: reduced easily with soda.

Analysis by Blum from Goldkronach:—

Antimony	75·8
Oxygen	19·5
Water	4·7
	100·0

Formula, $\dddot{Sb}\overset{\cdot\cdot}{\dddot{Sb}}+2\dot{H}$; with antimony, 75·89; oxygen, 18·82; water, 5·29: or antimonic acid, 49·70; oxide of antimony, 45·01; water, 5·29.

Localities.—The antimony-ochre accompanying Bleinierite and Jamesonite, at Trevinnick, near Endellion, Cornwall, appears to be this variety.

202. BLEINIERITE, *Nicol, Dana*; Bleiniere, *Hausmann, Hermann*. Antimoniate of Lead. Antimonsaures Bleioxide. Antimonite of Lead.

Amorphous, reniform, spheroidal; also earthy and incrusting; structure often curved lamellar. Lustre resinous to vitreous, dull or earthy. Colour white, grey, yellow, brown. Streak white, greyish or yellowish. Opaque to translucent. H. 4; Gr. 3·933, Karsten; 4·6 to 4·76, Hermann; 5·05 *white*, and 4·707 *brown*, from Cornwall, Heddle.

In the test-tube gives out water and darkens in colour. Before the blowpipe on charcoal fuses to a metallic globule, gives out fumes of antimony, and finally yields a bead of lead.

Analyses: *a* and *b*, *white*; *c*, *brown*, from Cornwall, all by Heddle; *d*, from Cornwall, by Percy; *e*, from Nertschinsk, in Siberia, by Pfaff; *f*, from Nertschinsk, by Hermann:—

	a.	*b.*	*c.*	*d.*	*e.*	*f.*
Antimonious acid .	42·216	42·44	46·70	47·36	43·96	31·71
Arsenic acid . . .	...	...	trace	...	16·42	...
Oxide of lead . . .	47·045	46·68	43·94	40·73	33·10	61·83
Oxide of copper . .	...	...	...	...	3·24	...
Peroxide of iron . .	...	...	1·44	...	0·24	...
Silica	...	...	...	...	2·34	...
Sulphuric acid . .	...	...	...	...	0·62	...
Lime	...	...	1·344	...	...	...
Water	11·497	11·98	6·460	11·91	...	6·46
	100·758	101·10	99·884	100·00	99·92	100·00

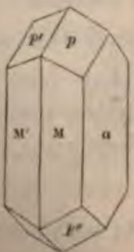
In *f* the acid was the antimonic; *c* absorbed from 3·05 to 4·07 per cent. of water, and was somewhat contaminated with antimony-ochre. That different substances have been here analysed there can be no doubt. Dr. Heddle gives as the formula for the Cornish mineral, $\dot{P}b^3\ddot{S}b^2+10\dot{H}$; with antimonious acid, 43·13; oxide of lead, 44·82; water, 12·05. Hermann gives for the Nertschinsk mineral, $\dot{P}b^3\ddot{S}b+4\dot{H}$; with antimonic acid, 31·32; oxide of lead, 62·01; water, 6·67. Notwithstanding this obvious difference between the Cornish mineral and the Bleiniere from Siberia, we have not felt ourselves justified in giving it a separate name, as, like the Siberian mineral, it is evidently a product of decomposition, and the above name appears already to have been applied to more than one such substance.

The Cornish mineral, which is much better marked in its general appearance than the Siberian, is directly the result of the decomposition of Jamesonite, with which it is associated.

Locality.—Has occurred lately at Trevinnick mine, near Endellion, in Cornwall, with Jamesonite and antimony-ochre, in large detached masses near the surface of the ground, having a crystalline and vitreous lustre, a rather lamellar structure, and varying in colour from white, through various shades of yellow, to brown.

203. ANTIMONITE.—Sulphuret of Antimony, *Phillips*; Antimonite, *Brooke* and *Miller*; Antimoine Sulfuré, *Hauy*; Stibine, *Beudant*; Antimonglanz, *Naumann*; Antimonit, *Haidinger*, *v. Kobell.*

Prismatic. Primary form a right rhombic prism of 89° 15′ and 90° 45′. Cleavage brilliant and perfect parallel to *h*, less so parallel to M. Fracture conchoidal, small, and imperfect. Opaque. Lustre metallic. Lead-grey, frequently blackish, or with an iridescent tarnish. Streak lead-grey. Sectile. In thin leaves flexible. H. 2; Gr. 4·6 to 4·7.



M M′	89°	15′
M *a*	134	37
M *p*	145	29
p a	125	22
p′ *p*	109	16

Before the blowpipe it fuses very easily on charcoal, colouring the flame greenish, is volatilized, and leaves a white deposit upon the support. In the open tube yields first a sublimate of antimonious acid, and then of oxide of antimony. Soluble in heated hydrochloric acid, leaving only a slight residue of chloride of lead. Decomposed by nitric acid, leaving oxide of antimony. Decomposed also by caustic potash; the solution yields a yellowish-red flaky precipitate on the addition of hydrochloric acid.

Analyses: *a*, by Thomson; *b*, in crystals, from near Arnsberg in Westphalia, by Schnabel:—

	a.	*b.*
Antimony	73·77	72·02
Sulphur	26·23	27·85
Iron	...	0·13
	100·00	100·00

$\overset{\prime\prime\prime}{\mathrm{Sb}}$; with antimony, 72·88; sulphur, 27·12.

Occurs in long columnar or acicular crystals, radiating columnar, in fibrous and granular masses, and disseminated.

According to G. Rose, antimonite is isomorphous with bismuthine.

Localities.—*England.* Cornwall; antimonite occurs abundantly in veins near Padstow and Tintagel; it is met with crystallized, fibrous, and massive. The veins have a north and south direction. Beautifully crystallized, lately, in the form shown in the figure, at Huel Boys in Endellion. At Trewethen, Port Isaac, and Pendogget in St. Kew. The plumose variety has also been met with at Huel Boys. Near St. Minvers.

Cumberland; at Robin Hood mine, Bassanthwaite, and at Carrock Fells. In the Isle of Man; sparingly, about ten years ago, at Dalby, in the south-west of the island.

Scotland.—At Hare Hill, near New Cumnock, Ayrshire, some 100 tons have been lately raised; it here occurs in quantity, but the workings have been discontinued. In Perthshire; near

Ben Lawes, on the Marquis of Breadalbane's estate. In Dumfriesshire; some years ago a radiated variety was met with at Glendinning, ten miles from Langholm. In Banffshire; at Keith, radiated.

204. BERTHIERITE, *Poggendorff*; Haidingerite, *Berthier*.

Occurs in a fibro-massive or granular state. Lustre metallic, but less so than in antimony-glance. Colour dark steel-grey, inclining to brown; surface sometimes slightly iridescent. H. 2·0 to 3·0; Gr. 4·2.

Analyses: *a*, from Chazelles, by Berthier; *b* and *c*, from Braunsdorf, by Rammelsberg:—

	a.	*b.*	*c.*
Sulphur	30·3	30·57	31·33
Antimony	52·0	54·34	54·70
Iron	16·0	11·96	11·43
Zinc	0·3	traces	0·74
Manganese	...	0·46	2·54
	98·6	97·33	100·74

Formula, $2\overset{'''}{\mathrm{Sb}}+3\overset{'}{\mathrm{Fe}}$; with antimony, 53·1; iron, 17·3; sulphur, 29·6.

A specimen from Cornwall, probably Berthierite, afforded, by a blowpipe examination, about 10 per cent. of iron and 9 per cent. of lead and zinc, in addition to the sulphur and antimony, the lead probably being an accidental mixture.

Before the blowpipe Berthierite gives out fumes of sulphur and antimony, leaving as residue a black magnetic slag. Easily dissolves in muriatic acid, giving out sulphuretted hydrogen. As an ore it yields antimony, but of an inferior quality.

Occurs in the neighbourhood of Padstow in Cornwall, of a steel-grey colour, and with a fibro-crystalline structure.

Order XV. BISMUTH.

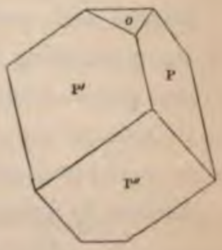
205. BISMUTH.—Native Bismuth, *Phillips*; Bismuth Natif, *Hauy*; Wismuth, *Haidinger, Hausmann, v. Kobell*; Wismut, *Naumann*.

Rhombohedral. P P′ being 87° 40′, according to G. Rose, and therefore very closely resembling the cube. Cleavage very perfect parallel to *o*; with P *o* 123° 36′. The crystals are usually distorted, or so grouped as to become indistinct. Also in reticulated and dendritic forms; granular and foliated. Reddish silver-white, liable to tarnish. Very sectile, not malleable. Lustre metallic, streak the same. H. 2·5; Gr. 9·6 to 9·8.

Chemical composition, Bi; frequently containing arsenic. Very readily fusible before the blowpipe; upon charcoal it volatilizes, depositing a lemon-yellow sublimate of oxide of bismuth. Soluble in nitric acid; a white precipitate is thrown down on the addition of a large quantity of water to the solution.

Occurs in veins in primitive and transition rocks, usually associated with cobalt and silver ores, and in tin lodes.

Localities. — *England.* Cornwall; formerly at Dolcoath, Camborne, and at Herland mine. In some quantity at Botallack, St. Just; small crystals, in jasper, are met with in this mine. Crystallized, as in the figure, at Wheal Sparnon, Redruth, associated with smaltine and erythrine. At Trugoe mine, St. Colomb. Lately, very fine and pure specimens, lamellar and of a tin-white colour, have occurred at the Consolidated mines, St. Ives. Masses of some pounds weight are said to have been found loose in the soil in the neighbourhood of Redruth.



With telluric bismuth and sulphuret of bismuth, in quartz rock, Calbeck Fells, Cumberland.

Scotland.—Stirlingshire; at Alva, formerly; reticulated, and associated with erythrine.

Native bismuth is the only mineral from which metallic bismuth is obtained on a large scale. *Arsenical* bismuth occurs near St. Just in Cornwall, and *cupreous bismuth* is said to occur at Huel Buller.

The following particulars relative to the behaviour of bismuth, when subjected to the influence of magnetism, are borrowed from the 'Mineralogy' of Brooke and Miller. Bismuth is feebly repelled by either pole of a magnet. A bar of bismuth suspended freely between the poles of a magnet rests in a position at right angles to the line joining the poles. When a crystal of bismuth is suspended between the poles of a magnet, the principal cleavage plane *o* tends to place itself at right angles to the line joining the poles. Also when bismuth crystallizes from fusion between the poles of a powerful magnet, most of the crystals have their principal cleavages perpendicular to the line joining the poles.

206. BISMUTH OCHRE.—Oxide of Bismuth.

Massive and disseminated; pulverulent, earthy. Opaque. Lustre glimmering, dull, earthy. Colour greenish-yellow, straw-yellow, greyish-white. Fracture conchoidal. Gr. 4·36.

On charcoal before the blowpipe easily reduced to the metallic state, and by prolonging the fusion it is nearly entirely dissipated.

Analysis by Lampadius:—

Oxide of bismuth	86·4
Oxide of iron	5·1
Carbonic acid	4·1
Water	3·4
	99·0

Formula, $\ddot{\text{B}}\text{i}$; with bismuth, 89·65; oxygen, 10·35.

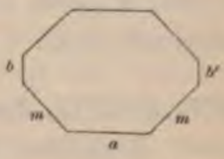
Bismuth ochre has occurred in Cornwall, at the mine Cost-all-Lost in the parish of St. Roach; also lately at the Royal Iron mine near Lostwithiel.

Note.—An earthy steatitic mineral from Wheal Coates near St. Agnes, found many years since, afforded Macgregor, oxide of bismuth, 28·8; carbonic acid, 51·3; peroxide of iron, 2·1; alumina, 7·5; silica, 6·7; and water, 3·6. It has passed under the name of carbonate of bismuth, or Agnesite, but it is probably an impure bismuth ochre. A specimen from Mr. Macgregor, in the late Mr. Allan's collection, is of a reddish-white colour, and does not effervesce in muriatic acid. The quantity of carbonic acid given by Macgregor appears to be excessive.

207. BISMUTHINE.—Bismuthine, *Brooke* and *Miller*; Sulphuret of Bismuth, *Phillips*; Bismuth Sulfuré, *Hauy*; Bismuthine, *Beudant*; Wismutglanz, *Naumann*; Wismuthglanz, *Hausmann*; Bismuthin, *Haidinger*, *v. Kobell.*

Prismatic. Primary form a right rhombic prism. Cleavage very perfect parallel to *a*, less so parallel to *b*. Fracture imperfect conchoidal, seldom observable. Opaque. Lustre metallic. Light lead-grey, inclining to tin-white; acquires a yellowish or variegated tarnish. Streak the same. Sectile. H. 2·0 to 2·5; Gr. 6·4 to 6·6.

$m\,m'$	89° 00′
$m\,a$	134 30
$b\,a$	90 00



The figure shows the section of a Cornish crystal.

In the open tube gives a sublimate of sulphur, with disengagement of sulphurous acid, and then boils. Upon charcoal melts readily in the reducing flame with effervescence, yields a yellow sublimate and a globule of bismuth. Partially soluble in nitric acid, leaving a residue of sulphur.

Analyses: *a*, from Cornwall, by Rammelsberg; *b*, massive, from Orawicza in the Bannat, by Hubert:—

$\overset{\prime\prime\prime}{\text{Bi}}$

	a. Gr. 6·405.	*b*.
Sulphur . . .	18·42	19·46
Bismuth . . .	78·00	74·55
Copper . . .	2·42	3·13
Iron	1·04	0·40
Lead	...	2·26
Gold	...	0·53
	99·88	100·53

The formula requires bismuth, 80·74; sulphur, 19·26. According to G. Rose, bismuthine is isomorphous with antimonite. In attached and imbedded crystals, in granular or columnar aggregations of foliated or radiated structure, and disseminated.

Localities.—In Cornwall; at Dolcoath, in Camborne, in small crystals. Crystallized, formerly, at Huel Sparnon, Redruth. In St. Just, at Botallack; also at Huel Cock: at the latter locality in tarnished crystals. At Herland mine, Gwennap. At Fowey Consols, Tywardreath, recently; also, lately, with Childrenite, at George and Charlotte mine near Callington. At Lanescot mine near St. Austell. In stream-works at St. Colomb.

Near Tavistock, lately, well crystallized.

Cumberland; fibro-lamellar and compact, at Brandy Gill, Carrock Fells, in quartz, with bismuth, telluride of bismuth, molybdenite, and apatite.

208. TETRADYMITE, *Hausmann*, *Haidinger*; Bornite, *Beudant*. Xaphyllite. Telluric Bismuth. Tellurwismuth.

Rhombohedral. Rarely crystallized; generally presenting a foliated or lamellar structure. Lustre metallic. Colour, externally, often lead-grey; internally, splendent and shining. Sometimes sectile. Laminæ firm and slightly elastic. Soils paper. H. 1·5 to 2·0; Gr. 7·2 to 7·5.

With the blowpipe fuses instantly, tinging the flame blue, and covering the charcoal with a whitish or yellowish colour. Soluble with effervescence in nitric acid. In the open tube gives off white fumes.

Analyses: *a*, from Cumberland, by Rammelsberg; *b*, from Schubkau, by Werle; *c*, from Brazil (*Bornite*), by Damour; *d*, from Davidson Co., N. Carolina, by Genth; *e*, from Virginia, by Fisher:—

	a.	*b.*	*c.*	*d.*	*e.*
Bismuth . .	83·30	60·0	79·15	61·35	54·81
Tellurium . .	6·65	34·6	15·93	33·84	37·96
Sulphur . .	6·33	4·8	3·15	5·27	...
Selenium . .	(1·22 $\dddot{\text{Si}}$)	traces	1·48	traces	7·23
	97·50	99·4	99·71	100·46	100·00

Formula, $\overset{\prime}{\text{Bi}}+2\,\text{BiTe}$; with bismuth, 59·59; tellurium, 35·91; sulphur, 4·50. In analysis *a*, the proportions approximate bismuth 12 atoms, sulphur 4, tellurium 1; the per-centages of which would be, bismuth, 86·89; sulphur, 6·59; tellurium, 6·54; but the formula to be deduced from these numbers is far from evident.

According to G. Rose and Hausmann, the proportions of bismuth and tellurium may vary considerably in this mineral, being isomorphous; while the sulphur and selenium are unessential ingredients.

In this country occurs in quartz rock, in foliated masses, composed of laminæ, which, when newly separated, possess a very brilliant metallic lustre, at Brandy Gill, Carrock Fells, in Cumberland; it is associated with sulphuret of bismuth, native bismuth, and sulphuret of molybdenum. The Cumberland telluric bismuth would appear to differ much in composition from other tetradymites, and used formerly to be considered to be sulphuret of bismuth, but it can be readily distinguished from that mineral by its inferior brittleness and superior lustre; the sulphuret of bismuth at this locality also differs from it in having a *fibro*-lamellar structure.

Order XVI. URANIUM.

209. ZIPPEITE, *Dana*. Uranochre. Uranblüthe.

Earthy and pulverulent. Amorphous; fracture earthy. Opaque, dull. Colour lemon or sulphur-yellow; sometimes glimmering, stained brownish-red. Soft, friable.

Dissolves readily in acids, yielding a yellow solution, which affords a brown precipitate with prussiate of potash. Heated gently it becomes orange-yellow. In the reducing-flame changes to green, but does not fuse.

Probably $\dddot{\mathrm{U}}$ with some water, and is said to be mixed with some carbonic acid.

Usually accompanies pitchblende, and was formerly found rather abundantly at the Callington tin-mine quite free from any carbonic acid.

Formerly also at Carharrack, two miles south of St. Day. At the Withiel iron-mine, Restormel; also at Wheal Edward, near St. Just. Mr. Nuttall found some good specimens near St. Michael's Mount coating mica on a quartzose rock; a specimen given Mr. Greg by Mr. Nuttall appears to be slightly crystallized in plates, as if the result of the decomposition of uranite; colour pale sulphur-yellow, and with a glimmering lustre. Formerly in small green earthy globules, on pitchblende, at Wheal Buller, Redruth.

210. PITCHBLENDE, *Phillips*; Uranine, *Haidinger*; Pechuran, *Hausmann*. Protoxide of Uranium.

Cubic. Usually massive and botryoidal; also in grains; structure sometimes columnar, or curved lamellar. Lustre submetallic or greasy, dull. Colour greyish, greenish or reddish-black. Opaque. Fracture conchoidal, uneven, slightly shining. H. 5·5; Gr. 6·46 to 6·8.

Infusible *per se* before the blowpipe; with borax yields a yellow globule in the outer flame, and a greenish one in the inner flame. Dissolves in hot nitric acid, forming a yellow solution.

A foreign specimen from Joachimsthal gave Rammelsberg,—

Oxide of uranium	79·15
Lead	6·20
Bismuth	0·65
Iron	3·03
Arsenic	1·13
Lime	2·81
Magnesia	0·46
Silica	5·30
Water	0·36
	99·09

Formula? essentially $\dot{U}\ddot{\bar{U}}$; uranium, 84·78; oxygen, 15·22.

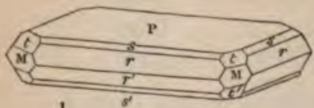
Mr. Morson, of Southampton Street, London, has lately analysed some specimens of pitchblende from Cornwall, which he found not to be so rich in uranium as those from some foreign localities; possibly the substance he examined may be the species *Eliasite,* found sparingly at Joachimsthal, in Bohemia, which only contains 61·33 of oxide of uranium, with 10·68 of water.

Localities.—Cornwall; about thirty years since at Huel Edward, St. Just; *sparingly* at Botallack mine; in Gwennap at Ting Tang mine, and at Tolcarne; in reniform masses, at Tin Croft mine, near Redruth, with uranite; at Huel Trenwith, and at Wheal Providence, near Camborne; at the latter mine in 1842 or 1843 several tons were raised, which sold for £30 a ton.

Pitchblende is usually associated with ores of silver and lead, and is often found along with uranite. Oxide of uranium is employed in porcelain painting, affording an orange colour in the enamelling fire, and a black colour in that in which the porcelain is baked.

211. URANITE.—Uranite (in part), *Phillips*; Torberite, *Brooke* and *Miller*; Chalcolite, *Beudant*; Kupfer-uranit, *G. Rose*; Chalcolith, *Haidinger*, *Hausmann*, *v. Kobell.*

Pyramidal. Crystals usually affect a tabular form, owing to the preponderance of the faces P *r*. Basal cleavage very perfect. Rather brittle. Lustre of P pearly, surface smooth; M rough. Lustre of the other planes vitreous, inclining to adamantine. Colour grass- to emerald-green, likewise verdigris-green and leek-green. Translucent to transparent. Streak apple-green. H. 2 to 2·5; Gr. 3·5 to 3·6.



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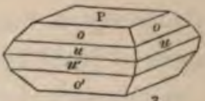

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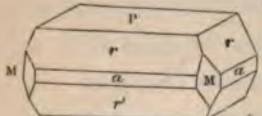

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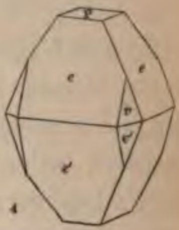

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P M	90° 00′	P *l*	115° 38′	P *o*	136° 45′
M M	90 00	P *v*	107 35	P *e*	128 35
M *a*	135 00	P *x*	147 56	P *r*	111 45
P *t*	134 50	P *s*	140 07	P *u*	109 34

(*l* replaces the edge *t*, *v*.)

Cornish forms: *e*; *e* P; *e v* P; *e v* P *t*; *r v* P *t*; *r* P; *s u* P; *o* P; *u o* P; *s* P *a*; *x o* P; M *o* P; *r s* P; M *r s* P *t*; *r s* P *a*; M *r* P; M *r* P *a*; *r s* P *t*; M *u s* P *l*; M *u s* P *a*. These forms were determined from crystals principally in Mr. Greg's collection.

In the matrass yields water. On charcoal with soda gives a bead of copper, and the reaction of copper with salt of phosphorus to which tin has been added, moistened with hydrochloric acid, tinges the flame blue; soluble in nitric acid; the solution is yellowish-brown; boiled in caustic potash it becomes brown, and is decomposed by carbonate of ammonia.

Analysis of a specimen from Gunnis Lake, by Werther:—

Oxide of uranium . . .	59·03
Oxide of copper . . .	8·27
Phosphoric acid . . .	14·34
Water	15·39
	97·03

$(\dot{Cu}+\ddot{\bar{U}}^{2})\overset{\cdot\,\cdot}{\dddot{\bar{P}}}+8\dot{\bar{H}}$; with oxide of uranium, 61·2; oxide of copper, 8·4; phosphoric acid, 15·1; water, 15·3.

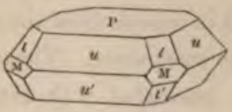
Localities.—*England.* Cornwall; magnificent specimens of this beautiful species were met with in considerable abundance at Gunnis Lake, near Callington, some years since. They occurred in large thin aggregated plates, associated with smoky-grey quartz, at the depth of about 90 fathoms from the surface. Several young mines being now in work in the immediate neighbourhood of Gunnis Lake, there is every hope that specimens of equal beauty to those contained in collections of some years' standing will be again met with. At Wheal Edward, near St. Just. At Ting Tang and Tolcarne, in Gwennap. At Wheal Gorland and Wheal Unity. In attle-heaps at Tincroft mine, Pool, Illogan. In small dark-green crystals, highly modified, at Wheal Buller, Redruth. Lately, in very fine thick dark-green crystals, in gossan, at Wheal James copper and iron mine, Withiel. At Stenna Gwynn, near St. Austell, in small pale crystals, associated with fluellite and Wavellite. A year or two since, as well as formerly, at South Wheal Basset, near Redruth. The specimens from this locality, and also from Wheal Buller, are reported to have been very phosphorescent when discovered.

Devonshire; at Bedford United mines, near Tavistock, in small crystals.

Ireland.—Said to occur in fine crystals, at new copper mines, near Skull, Co. Cork.

212. AUTUNITE.—Autunite, *Brooke* and *Miller*; Uranite (in part), *Phillips*; Kalk-uranite, *G. Rose, Naumann*; Autunit, *Haidinger*.

Pyramidal ?. Forms and angles are supposed to be the same as those of uranite. The crystals almost always tabular, generally set singly on the matrix or united in small druses. Cleavage basal, very perfect. Siskin-green to sulphur-yellow. Streak yellow. Lustre pearly on terminal plane, on the other resinous. Fracture not observable. Transparent to translucent. H. 1 to 2; Gr. 3 to 3·2.



M P	90°	00′
P *l*	115	53
P *u*	109	32
M M	90	00

In the matrass yields water and becomes straw-yellow; on charcoal fuses to a dark mass, semi-crystalline on the surface; with soda forms a yellow infusible slag, soluble in nitric acid; the solution is yellow. According to Werther it is decomposed by carbonate of ammonia.

Analyses: *a*, from Autun, by Berzelius; *b*, by Werther:—

	a.	*b.*
Phosphoric acid	15·20	14·00
Oxide of uranium	61·73	63·28
Lime	5·88	5·86
Magnesia and protoxide of manganese .	0·20	. . .
Barytes	1·57	1·03
Oxide of tin	0·06	. . .
Water	15·48	14·30
	100·12	98·47

$\dot{\mathrm{C}}\mathrm{a}^2\overset{\cdot\cdot\cdot\cdot\cdot}{\bar{\mathrm{P}}}+\dddot{\bar{\mathrm{U}}}{}^4\overset{\cdot\cdot\cdot\cdot\cdot}{\bar{\mathrm{P}}}+16\dot{\bar{\mathrm{H}}}$, or rather, expressing the formula as first suggested by Mitscherlich and adopted by Werther, $(\dot{\mathrm{C}}\mathrm{a}+\dddot{\bar{\mathrm{U}}}{}^2)\overset{\cdot\cdot\cdot\cdot\cdot}{\bar{\mathrm{P}}}+8\dot{\bar{\mathrm{H}}}$, which corresponds to 62·6 oxide of uranium, 15·5 phosphoric acid, 6·2 lime, 15·7 water.

Formerly in small bright yellow, and nearly transparent crystals, at South Basset: there is a specimen from this locality in the British Museum. Also many years ago at Tolcarne mine, two miles from Carharrack, near St. Day, at 30 fathoms depth, and of a pale yellow colour, inclining to green. Also at Wheal Edwards, about thirty years since; and the specimens mentioned in the preceding species as occurring along with fluellite at Stenna Gwynn, may belong to this.

The forms and angles given above were obtained from small but very brilliant yellow and transparent crystals in Mr. Greg's collection, detached from a Cornish specimen.

Note.—The yellow phosphate of uranium (Autunite) is not isomorphous with the green phosphate according to Descloiseaux (L'Institut, No. 1207), for it has two axes of double refraction, or is prismatic and not pyramidal. (See Silliman's Journal, No. 70, July 1857.) Primitive form, in all probability, a right rhombic prism of 92° 30′.

Order XVII. LEAD.

213. NATIVE LEAD.

Found in small globules. H. 1·5; Gr. 11·44.

Lustre metallic. Colour lead-grey. Malleable and ductile.

Hitherto only found in small globules in lava, and in the cavities of a meteoric iron. (See Philosophical Magazine, July 1855.)

Native lead has been found, however, *in situ* at Alston Moor, in veins traversing limestone very near the surface, in small detached masses of galena bearing the aspect of torrefaction, and which are coated with oxide of lead. The metallic lead occurs in small globules dispersed over the surface.

It is now known that the Romans worked the lead ore at this locality, and the way they worked was to smelt or roast the ore *in situ, i. e.* by digging away some of the earth on both sides of the metallic lode or vein, and putting in fuel and fire. In this way the galena must have been more or less roasted, thus accounting for the globules of pure lead*.

Note, 1857.—Native lead has been recently discovered in undoubtedly genuine specimens in the province of Guanaxuata, in Mexico. There is a specimen in the Museum of Economic Geology, in Jermyn Street, London.

214. MINIUM.—Native Oxide of Lead.

Fracture earthy; even, flat, conchoidal. Opaque. Lustre feeble. Colour red. Streak orange-yellow. H. 2·5; Gr. 4·6.

Contains,—

Lead	90·66
Oxygen	9·34
	100·00

Formula, $\dot{\mathrm{P}}\mathrm{b}$.

Slightly heated grows darker, resuming its bright red colour on cooling. Before the blowpipe at a red heat becomes yellow, melts easily, and is reduced on charcoal.

In muriatic acid is converted into chloride of lead, with evolution of chlorine. Partially soluble in nitric acid. Occurs massive or disseminated, earthy, and generally with galena. It is not, however, a common ore of lead.

Localities.—*England.* Anglesey; in veins of clay-slate with galena. Merionethshire.

At Alston, in Cumberland.

Shropshire; at Snailbeach mine.

Yorkshire; at Grassington Moor, near Craven. At Weardale, and at Grasshill Chapel.

Scotland.—At Leadhills.

Ireland.—Co. Wicklow; at Lugganure.

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* The native lead mentioned in the edition of Phillips by Brooke and Miller, as occurring near Bristol, has been since shown to have originated in the firing of rifle-bullets!

215. PLATTNERITE, ***Haidinger.*** Superoxide of Lead.

Rhombohedral ?. In hexagonal prisms with edges truncated. Fracture uneven. Opaque. Cleavage indistinct. Lustre adamantine, inclining to metallic. Colour iron-black, acquires a tarnish, and then becomes dull. Streak brown. Brittle. Gr. 9·4.

Easily reduced before the blowpipe on charcoal.

Contains, according to Plattner and Lampadius,—

Lead	86·62
Oxygen	13·38
	100·00

It is said to have come from Leadhills.

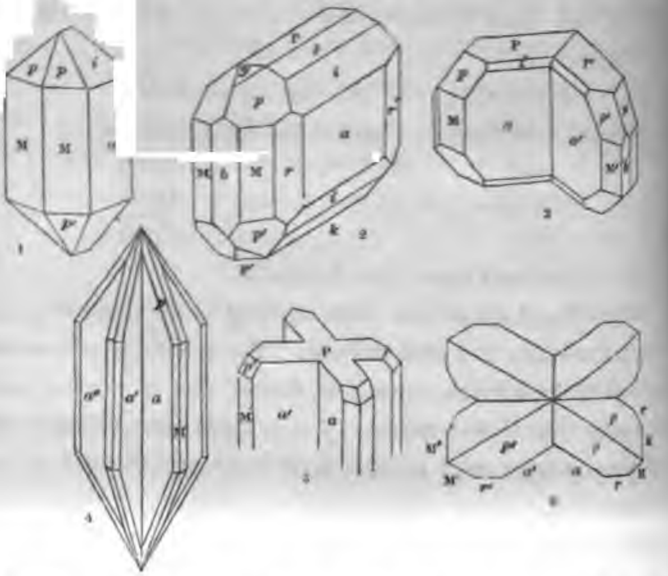
Note.—The Authors can learn nothing more about this species, and consider it a doubtful one. The specific gravity seems too high to be correct, since it is double that of minium, and even more than that of galena. The crystals described as being hexagonal prisms may possibly have been pseudomorphous of pyromorphite.

216. CERUSSITE.—Cerussite, *Brooke* and *Miller*; Carbonate of Lead, *Phillips*; Plomb Carbonaté, *Hauy*; Céruse, *Beudant*; Bleicarbonat, *Naumann*; Cerussit, *Haidinger, v. Kobell.*

Prismatic. Primary form a right rhombic prism. Cleavage parallel to M and *l* tolerably perfect, traces paralled to *a*. Faces *a* striated parallel to intersection with *i*. P often rough. Twin-face M. Fracture conchoidal. Transparent to translucent. Lustre vitreous, inclining to resinous on surface of fracture. Colourless, white, grey, lead-grey, reddish-brown, occasionally green, owing to an admixture of carbonate of oxide of copper, black. Streak white. Rather brittle. H. 3 to 3·5; Gr. 6·4 to 6·6.

Before the blowpipe in the closed tube decrepitates violently,

, loses its carbonic acid, after which its comport-
' oxide of lead. Reduced to lead upon charcoal.
ffervescence in nitric acid. The solution yields a
it the addition of sulphuric acid.



M M	117°	13′	M *i*	145°	20′	*p p′*	108°	28′	*r r′*	122°	43′
M P	90	00	M *k*	125	52	*x x*	39	45	*y y′*	61	18
a b	90	00	P *y*	149	21	*k k*	71	44	*a r*	151	22
P *b*	90	00	*p p*	130	00	*i i*	110	40	*a i*	145	10
M *a*	121	24									

Combinations: M*ap*; *apx*; M*pix*; M*apk*; M*api*; M*a*P*ix*; M*a*P*ixkr*; M*api* (*b*), (*r*), (*ky*), (*r b*), (*kr*), (*bx*); M*a*P*iybr*; M*a*P*iy*; P*abpy*; P*abpkx*; M*ap ixy*; M*a*P*piky*; M*a*P*bpi*; M*a*P*pskr*; M*a*P*bpr* (*k*), (*ixk*), (*ixksoyw*); M*a*P*bpiy*.

Analysis of Cerussite from Leadhills, by Klaproth :—

$\dot{\mathrm{P}}\mathrm{b}\ddot{\mathrm{C}}$	Oxide of lead	82
	Carbonic acid	16
		98

The formula requires oxide of lead, 83·45; carbonic acid, 16·55.

In crystals; fibrous, compact, and in earthy masses. Occurs also *pseudomorphous* after galena, Leadhillite, and Anglesite at Leadhills. In some of the Missouri mines it is met with pretty abundantly, but in this country it does not occur in sufficient quantity to be of much value as an ore of lead.

LOCALITIES.—*England.* Cornwall; at Wheal Golden and Huel Ann, Perranzabuloe. A snow-white acicular variety occurred at St. Minver Consols, and at Pentire Glaze in St. Minver; in some of the specimens first found the crystals were 10 inches long. At Huel Alfred and Huel Penrose, near Helstone. At Huel Primrose and Park Mathews, near St. Austell. At Huel Rose and Huel Confidence, and at St. Crenver.

Devonshire; with Anglesite, in fine crystals, in decomposed galena, at East Tamar mine, Beerferris.

Derbyshire; it occurs very generally, but is met with principally at mines in the neighbourhood of Matlock and Wirksworth. Very finely crystallized, formerly, at the Plackett mine near Winster, and at the Cromford Level mine near Matlock, where it occurred in dark-brown macled crystals on galena. Lately, in large dark-grey translucent crystals, of the form of figure 1, in geodes of cawk, with Anglesite, at Rent Tor near Wirksworth. At Hubberdale mine near Bakewell. At Crich mine. At Brassington.

Shropshire; at Snailbeach.

Cumberland; crystallized and acicular at Mexico mine, near Hesket Newmarket. Also at Red Gill and Bray Fell, Caldbeck Fells. At Greenside; Driggath, and Silver Gill mines. Finely acicular at Yenthwaite. At Goldscope mine near Keswick, and at Force Craig mine, near the same place, in small black macled crystals. Also at Nenthead.

Durham; at Burne mine; a black variety is met with in this county at Fairhill. Also at Weardale and in Teesdale.

Northumberland; at Fallowfield near Hexham, and Allenheads.

Yorkshire; finely crystallized, at Connonly mine near Skipton.

Westmoreland; at Patterdale.

In the Channel Islands; at the Sark mine.

Wales.—Flintshire; at Jamaica mine, and in the Halkin Mountains. In Cardiganshire; in magnificent translucent tabular crystals, at Logylas, one of the Lisburne mines, near Aberystwith; at Frongoch.

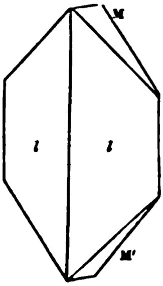
Scotland.—At Lossiemouth, Elgin. Leadhills in Lanarkshire, and Wanlock Head in Dumfriesshire, used to afford very perfect and brilliant crystals, presenting the forms of figures 2, 3, 4, 5 and 6, and accompanied with other lead salts. It also occurred at these localities in acicular crystals in gossan, and likewise, on quartz, in very fine intersecting plates, and in rosettes. All the forms given in the list of combinations have occurred at Leadhills.

Ireland.—Wicklow; in magnificent crystals of a light-brown colour, translucent, and in heart-shaped macles; also at Seven Churches, in fine specimens, white, reddish-brown and black. Co. Dublin, at an abandoned mine, at Scalp near Howth.

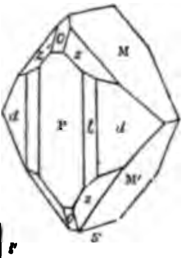
217. ANGLESITE.—Sulphate of Lead, *Phillips*; Anglesite, *Brooke* and *Miller*; Plomb Sulfaté, *Hauy*; Anglésine, *Beudant*; Bleisulphat, *Naumann*; Bleivitriol, *Hausmann*; Anglesit, *Haidinger*, *v. Kobell.*

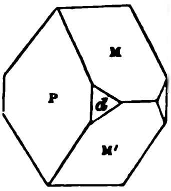
Prismatic. Primary form a right rhombic prism. Cleavage parallel to M and P, but not perfect. Structure often lamellar when in large masses. Fracture conchoidal. Transparent, translucent. Lustre adamantine, inclining to resinous. Colourless, yellow, grey, brown, sometimes tinged green, or black. Very brittle. H. 3; Gr. 6·2 to 6·3.

In the closed tube it decrepitates. On charcoal in the oxidating flame it fuses to a clear bead, which on cooling becomes milk-white. In the reducing flame it yields lead. With soda and silica gives the reaction of sulphur. In acids it dissolves with great difficulty, but is perfectly soluble in solution of caustic potash.



1





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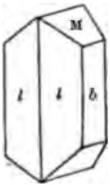

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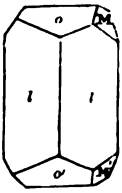


4

P M	90° 00′	P *o*	127° 45′	*l l*	135° 20′	*z z*′	89° 41′
P *b*	90 00	P *d*	140 38	*d d*	101 15	*o o*′	75 39
P *a*	90 00	P *θ*	160 38	*d d*′	78 45	*θ θ*	143 55
M M′	103 38	P *p*	125 42				

N.B. *θ* cuts the angle formed by *z* P *o*.

Combinations: M *l*; M *l* P, Cumberland. M *l*; M *z*; M *l* P; M *o l* (*b*), (*b z*), Derbyshire. M *l*; M *l* P; M *l* P *z*; M *l d o* P; M *d o z* P; M *d z a* P; M *d z* P; M *l θ z*; M *l θ z a*; M *l d o z θ* P; M *l o p*; M *l θ a*, Leadhills. M *d o z* P (*a*), (*p*), (*θ*), Anglesey. M *d o z* P, Cornwall.

Analyses: *a*, from Anglesey; *b*, from Wanlock Head, by Klaproth:—

		a.	*b.*
$\dot{P}b\dddot{S}$	Oxide of lead . .	71·0	70·50
	Peroxide of iron .	1·0	. . .
	Sulphuric acid . .	24·8	25·75
	Water	2·0	2·25
		98·8	98·50

The water obtained in both of these analyses cannot, however, be considered as proper to this species, which is, in truth, an anhydrous salt, consisting of oxide of lead, 73·61, and sulphuric acid, 26·39.

In attached crystals, in lamellar masses, and massive. Usually occurs with galena, from the decomposition of which it is evidently produced.

Localities.—*England.* Cornwall; formerly, in gossan, at Huel Maggot, Melanoweth.

Devonshire; in fine glassy colourless crystals, at East Tamar mine, Beerferris, in geodes of decomposed galena, recently; with the faces M and *z* predominating; near Liskeard, lately.

Cumberland; lately, at the Mexico mine near Hesket Newmarket, at Red Gill, and at Greenside mines; likewise at Bray Fell, Caldbeck. The Cumberland Anglesite is of the general form of figure 1.

Derbyshire; near Cromford, in small yellow crystals, figure 4, with Cromfordite. In well-crystallized specimens at Brassington Moor, at Eyam, and at Crich. In white translucent crystals, lately, with the form M *z*, near Middleton. In brilliant crystals, with the form of figure 3, recently, at Rent Tor near Wirksworth. Two of the finest crystals of Anglesite yet found in Great Britain or Ireland, and now deposited in Mr. Greg's collection (presenting the forms M *l*, M P *l*), one of them 4 inches in length, and also extremely perfect and translucent, came originally from the neighbourhood of Wirksworth, though the name of the precise mine was not mentioned.

Wales.—This mineral was for the first time recognized as a distinct species at Parys mine in Anglesey, where it was met with many years ago, in considerable abundance, in small yellow crystals of the form of figure 5. It is no longer found at this locality.

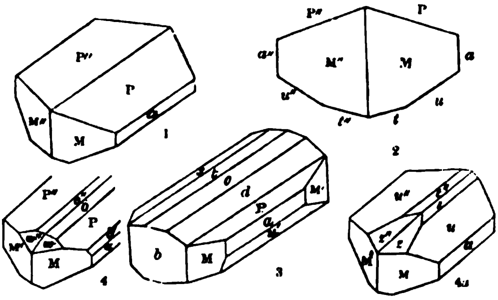
In the Channel Islands; at the Sark silver-mine.

Scotland.—Very fine specimens of Anglesite were formerly found at Leadhills in Lanarkshire, and at Wanlock Head in Dumfriesshire. The crystals from these localities combined various modifications of the forms represented in figures 1 and 5. Those of the form of figure 1 are dagger-shaped, translucent, and of a yellowish colour. They are sometimes nearly 2 inches long, and perfectly terminated.

Ireland.—With Cerussite, at Glenmalure lead-mines, in Wicklow; but few fine crystals have been found, however, there. At Ballycorus mine, Co. Dublin.

218. LINARITE, *Brooke* and *Miller*; Cupreous Sulphate of Lead, *Phillips*; Linarite, *Beudant*; Linarit, *Haidinger*, *v. Kobell*; Bleilasur, *Naumann*, *Hausmann*.

Oblique. Primary form an oblique rhombic prism. Twin-face *a*. Cleavage very perfect parallel to *a*. Often occurs



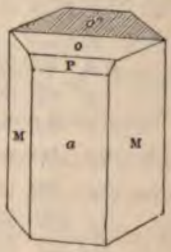
P M	96° 25′		*s a*	74° 25′		M *m*	150° 05′
M M	119 00		*x a*	62 30		*r r′*	160 06
M *a*	120 30		*u a*	51 54		M *r*	128 30
l a	140 38		*b a*	90 00		P *r*	141 25
y a	125 30		*b o*	90 00		M *w*	115 15
P *a*	102 45		P *f*	139 45		P *w*	158 08
d a	99 16		M *g*	137 20 ?		M *z*	94 00 ?
o a	96 18		M *n*	151 10		P P″	154 30 (in twins)
t a	78 59						

twinned. Fracture conchoidal. Lustre adamantine. Feebly translucent, transparent. Deep azure-blue. Streak dull and pale-blue. Brittle. H. 2·5; Gr. 5·3 to 5·45.

Figure 2 represents a section of figure 1, with plane of composition parallel to *a*; one half of a crystal being turned round one revolution on the other in the same plane: figure 4*a* shows the reverse of figure 4. The edges M *t*, M *s*, M *u* are occasionally slightly truncated. The forms *y*, *x*, *l*, *g*, *n*, *m*, *w*, *r* have not before been described. *y* cuts the edge P *a*; *x*, *s a*; *l*, M *a*; *g*, M *t* (?); *n*, P M; *m*, M *o*; *r*, M *w*. The faces M, *a*, P, *b*, *u*, *x*, *w*, *r*, brilliant; *o*, *z*, curved, or rough.

Combinations: twins, M P *o a*; M P *a o m*: *not* twinned, M P *a b s l*; M P *a b d o s t u*; from Leadhills. From Cumberland, *not* twinned, M P *a b s l*: twinned (like figure 1), M P *a t u*; M P *a b t u*; M P *a b o s*; M P *a t u y*; M P *a l t u*; M P *a s u x*; M P *a s r*; M P *a o t n u*; M P *a o t s u*; M P *a d t g s u*; M P *a t o u y w z*; M P *a t s u g r w*. The forms P, *x*, *t* and *u* are usually much more developed in the crystals from Cumberland than from Leadhills; at both localities the crystals are generally crystals of composition. Figure 3 represents a crystal in Mr. Brooke's collection from Leadhills. In the combinations M *o a*, M P *a o m*, owing to the absence of the forms *t*, *s*, *x*, *u*, the faces *o* and *o* P make with *o''* and *o''* P'' a very distinct re-entering angle at the terminations, a re-entering angle not usually being visible where either *t*, *s*, *x* or *u* are present (see figures 6 and 7).

The annexed forms (see figures 6 and 7) represent a large crystal from Leadhills in Mr. Greg's collection.



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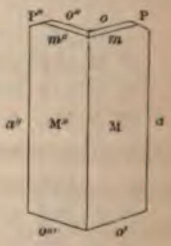


7

In the closed tube gives off some water, and loses its colour; in the reducing flame on charcoal yields a metallic bead, which, if the heat is kept up, deposits a coat of oxide of lead; treated with soda, it is likewise reduced with the formation of sulphide of sodium.

Analyses of Linarite from Leadhills: *a*, by Brooke; *b*, by Thomson:—

	a.	*b.*
Sulphate of oxide of lead . . .	75·4	74·8
Oxide of copper	18·0	19·7
Water	4·7	5·5
	98·1	100·0

$\dot{\mathrm{Pb}}\dddot{\mathrm{S}}+\dot{\mathrm{Cu}}\dot{\bar{\mathrm{H}}}$; with sulphate of oxide of lead, 75·7; oxide of copper, 19·8; water, 4·5.

Was formerly found at Leadhills in Lanarkshire, both crystallized and massive, associated with Cerussite.

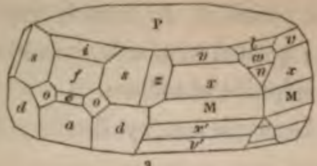
More recently it has been found pretty frequently at Mexico mine, Red Gill, and at Roughten Gill, near Keswick, in Cumberland.

The Cumberland crystals are usually crystals of composition, rather *flat* and doubly terminated, and most commonly small; but crystals an inch in length, and a quarter of an inch thick, have been met with quite brilliant and perfect.

The name *Linarite* is derived from Linares in Spain, where the species is *said* to have occurred.

219. LEADHILLITE.—Leadhillite, *Brooke* and *Miller*; Sulphato-tricarbonate of Lead, *Phillips*; Leadhillite, *Beudant*; Leadhillit, *Haidinger*, *v. Kobell.*

Prismatic. Primary form a right rhombic prism. Cleavage very perfect parallel to P, imperfect to M and *a*. Lustre P slightly pearly, the other faces vitreous to adamantine. Fracture conchoidal. Transparent to translucent. Colour yellowish-white to grey, yellowish-green, yellow, brown. Streak white. Rather brittle. H. 2·5; Gr. 6·2 to 6·4.



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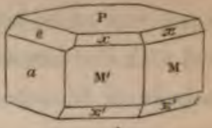
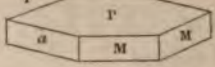
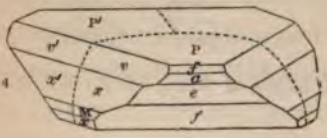


2

1





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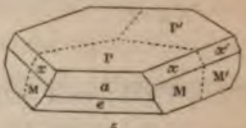


5

M M	120° 20′	P *a*	90° 00′	*v a*	113° 00′
M *a*	119 50	P *x*	111 30	*z a*	130 20
P *l*	151 10	P *v*	128 14	*s a*	137 54
P *w*	132 15	P *s*	125 58	*x f*	126 11
P *n*	105 36	P *z*	120 50	*s f*	161 08
P *i*	147 44	P *o*	111 09	*v i*	137 03
P *p*	139 30	P *y*	146 30	*o e*	168 33
P *f*	128 22	*d a*	156 27	*f f*	76 44 (over P)
P *e*	111 36	*x a*	117 34		

The following combinations, or forms, have been observed in specimens from Leadhills, nearly all as twin crystals, most of the similar faces being alternate and opposite.

P *e x*; P *e x f v*; M P *a*; M P *a f v*; M P *a p v*; M P *a e x*; M P *y f x*; M P *a f p v*; M P *a e f v x*; M P *a e f s v x*; M P *a f v p s*; M P *a e x s*; M P *a e i x v*; M P *a d e f l n o s v w x z*.

Large crystals, with the form M P *a*, may be seen in the collection of the British Museum.

Often twinned; twin-face *f*, figure 4, and ? M, figure 5. The forms *e*, *f*, *i*, and perhaps *o*, *s*, *v*, *x*, *z*, are frequently hemihedral, with parallel planes, so as to give the crystals, which are often tabular, an appearance of belonging to the hexagonal or rhombohedral system. Figure 5 shows a combination of three individuals, the base P being apparently divided into three panels, which run into each other at an angle of 179° 10′. The face *p* truncates the edge between *i* and *f*; *y*, a face also not given by Brooke and Miller, is inclined on the solid angle between M *a* and P.

Figure 3 represents a crystal of composition formed, according to Haidinger, of alternating plates, with the face of composition parallel to *f*. This, and figures 1 and 5, represent crystals in Mr. Greg's collection; figure 3 is from a crystal in Mr. Brooke's collection. Figure 1, taken from a minute compound crystal, represents only its supposed simple form.

Before the blowpipe intumesces somewhat, and turns yellow, but becomes white on cooling. On charcoal is easily reduced to lead.

Partially soluble, with effervescence, in nitric acid, leaving a residue of sulphate of oxide of lead.

Analyses: *a*, by Berzelius; *b*, by Thomson :—

	a.	*b.*
Sulphate of oxide of lead . .	28·7	27·43
Carbonate of oxide of lead . .	71·0	72·57
	99·7	100·00

$\dot{P}b\dddot{S}+3\dot{P}b\ddot{C}$; with sulphate of oxide of lead, 27·44; carbonate of oxide of lead, 72·56.

Localities.—Formerly in very fine specimens at Leadhills in Lanarkshire, accompanied by other lead salts. The crystals generally occur in geodes of the carbonate of lead. At this locality pseudomorphous crystals of calcite having the form of this mineral are occasionally met with.

It has been found recently in well-formed and brilliant crystals, sparingly, at Red Gill, Cumberland, in hollows in quartz, with Linarite and Cerussite.

In small brilliant crystals, with galena, in a pit sunk preparatory to opening a mine close to Kingston near Taunton, Somersetshire, at about a quarter of a mile from the village, on the road across the fields to Broomfield.

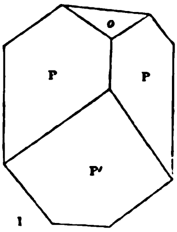
In the Channel Islands, at the old silver mine in Sark.

The following passage is taken from page 564 of the recent work of Brooke and Miller:—"Two mistakes have been committed in former descriptions of the crystals of Leadhillite. One by Mr. Brooke, in regarding Susannite and Leadhillite as having the same rhombohedral form and angles, an error into which he was led by the very near agreement of the angles *r o* of Susannite (P *o* of figure 1, Susannite) and *e c* (*e* P of figure 5), and by the occurrence of *e* alternately on the opposite sides of most of the twin-crystals of Leadhillite; the alternation of the faces *e* being due to the hemihedral character of the form to which they belong. M. Haidinger was also deceived by the hemihedral form of these crystals, and, not having sufficiently perfect ones for measurement, was led to suppose the form of Leadhillite to be oblique, and to be the only form belonging to this chemical compound. The opportunity, however, which we have lately had of measuring some very perfect crystals of Leadhillite has removed all doubt of their being prismatic."

Professor Dana considers that Anglesite and Leadhillite have homœomorphic fundamental prisms; the angle M : M = 103·38 in Anglesite coinciding with the angle *f f'* = 103·16 in Leadhillite; he has not perhaps, however, sufficiently considered the cleavages of these two species.

220. SUSANNITE.—Susannite, *Brooke* and *Miller*; Sulphato-tricarbonate of Lead, *Phillips*; Suzannit, *Haidinger*.

Rhombohedral. Cleavage parallel to *o* very distinct. Lustre, *o* pearly, on other planes adamantine to resinous. Transparent, translucent, opaque. Grey, pale green, yellow, dark brown. Streak white. H. 2·5; Gr. 6·55.



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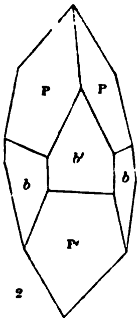


2

P P	72°	30′
P *o*	111	22
P *b*	158	32
b b′	120	00
b o	90	00
b b	60	00
s o	101	04
v o	93	12

Combinations and forms: P*o*; P*ob*; P*b*; P*obsv*: *v* truncates the edge P*b*; *s* $\bar{1}11$.

Chemical characters the same as those of Leadhillite.

Analysis by Brooke :—

Sulphate of oxide of lead	27·5
Carbonate of oxide of lead	72·5
	100·0

$\dot{P}b\ddot{S}+3\dot{P}b\ddot{C}$.

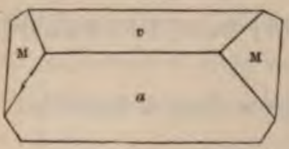
The compound $\dot{P}b\ddot{S}+3\dot{P}b\ddot{C}$ is dimorphous, being prismatic in Leadhillite, and rhombohedral in Susannite.

Is only known to have occurred at one locality in the United Kingdom, namely, on the Susanna lode at Leadhills, in Lanarkshire, where it was met with some years ago associated with Lanarkite, Leadhillite and cerussite.

It is of much rarer occurrence than Leadhillite, from which it is not always easy at first sight to distinguish it. The hexagonal character of the crystals is, however, in general wanting, the plane *o* being usually not sufficiently developed to lose its rhombohedral form. Another distinguishing point is the difference of the specific gravity of these two minerals, that of the densest varieties of Leadhillite being 6·43, and that of Susannite 6·55. This mineral has also occurred in crystals of tolerable size on brown iron ore and galena, at Moldawa, in the Banat. Some fine specimens of this variety of the sulphato-tricarbonate from Leadhills are preserved in the British Museum.

221. LANARKITE.—Lanarkite, *Brooke* and *Miller*; Sulphato-carbonate of Lead, *Phillips*; Lanarkite, *Beudant*; Lanarkit, *Haidinger*, *v. Kobell*.

Oblique. Cleavage *a* perfect, *v* less so. Lustre adamantine, inclining to resinous, and, on the perfect cleavage, to pearly. Transparent, translucent. Colour greenish or yellowish-white. Streak white. Rather sectile, in thin plates flexible. H. 2 to 2·5; Gr. 6·8 to 7·0. According to Thomson, Gr. 6·3 to 6·4.



M M	49°	50′
M *a*	114	50
M *v*	110	10
v a	120	45

M, *a* frequently curved and indistinct. Attached to matrix at M.

Before the blowpipe on charcoal fuses to a white bead containing lead. In nitric acid partially soluble, with effervescence, leaving a residue of sulphate of oxide of lead.

Analyses: *a*, by Brooke; *b*, by Thomson:—

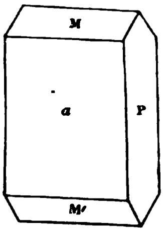
	a.	*b.*
Sulphate of oxide of lead . . .	53·1	53·96
Carbonate of oxide of lead . .	46·9	46·04
	100·0	100·00

$\dot{Pb}\ddot{S}+\dot{Pb}\ddot{C}$; with sulphate of lead, 53·15; carbonate of lead, 46·85.

Occurred formerly in long slender single crystals like the figure, and in diverging aggregations, from 1 to 2 inches in length, at Leadhills, in Lanarkshire, associated with Susannite and Caledonite. It is the rarest of the lead-salts met with at Leadhills, which is its only locality in the United Kingdom. The terminal plane M is very seldom distinct; the face *u* of Brooke and Miller is of rare if not of doubtful occurrence.

222. CALEDONITE.—Cupreous Sulphato-carbonate of Lead, *Phillips*; Calédonite, *Beudant*; Caledonit, *Haidinger*, *v. Kobell.*

Prismatic. Primary form a right rhombic prism. Cleavage imperfect parallel to M, *a*, P. Fracture uneven. Transparent to translucent. Lustre vitreous. Bluish-green, blue. Streak greenish-white. The faces P and *a* striated in general parallel to their intersection. Rather brittle. H. 2·5 to 3; Gr. 6·4.



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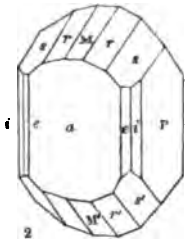

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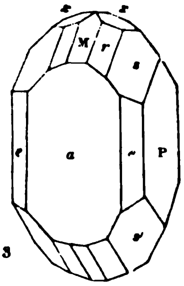


3

P *a*	90° 00′	P *e*	125° 29′	*r r′*	96° 45′
M P	90 00	*x x*	143 50	*r r*	128 35
M M′	85 00	*s s′*	106 31	*t t*	152 30
P *i*	163 15	*s s*	108 20	*e e*	109 03

Combinations: M P *a*; M P *a r*; M P *a r s e x*; M P *a r s e i*; M P *a e t r s i*: all from Leadhills. From Cumberland the form M P *a r s e*. The angles for *i* and *t* not before given. The face *t* replaces the edge M *r*.

Before the blowpipe on charcoal it is reduced. Partially soluble with slight effervescence in nitric acid, leaving a residue of sulphate of oxide of lead.

Analysis by Brooke:—

Sulphate of oxide of lead	55·8
Carbonate of oxide of lead	32·8
Carbonate of oxide of copper . . .	11·4
	100·0

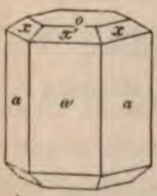
$6\dot{P}b\dddot{S}+4\dot{P}b\ddot{C}+3\dot{C}u\ddot{C}$; with sulphate of lead, 55·82; carbonate of lead, 32·81; carbonate of copper, 11·37.

Was till recently only known to occur at Leadhills, in Lanarkshire, accompanied by Leadhillite and Lanarkite, in attached crystals in the interior of geodes of cerussite, and in hollows formed by the decomposition of galena. The crystals are flattish and of the form of figures 1 and 2; they have not hitherto been met with above half an inch in length, and are generally much smaller.

It has more lately been found at Red Gill, in Cumberland, in quartz, with cerussite and Leadhillite. The crystals, which are of the form shown in figure 3, are small and distinct. Colour generally greener than in specimens from Leadhills.

223. PYROMORPHITE.—Phosphate of Lead.

Rhombohedral. Cleavage imperfect parallel to M. Fracture uneven, conchoidal. Lustre resinous to adamantine. Colour green, yellow, grey, and brown of different shades. H. 3·5; Gr. 6·9 to 7; F.=1·5. Not reducible alone upon charcoal, whereby it is distinguishable from arseniate of oxide of lead, with which it is isomorphous. Sometimes of a rich orange-red colour, which is caused by the presence of a small quantity of oxide of chromium. Streak white or pale yellow. Transparent, translucent, opaque.



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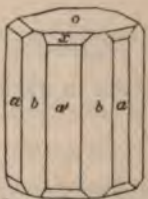


2

$a\,a'$	120°	00'
$o\,a$	90	00
$x\,a$	130	22
$o\,v$	106	23
$o\,x$	139	38
$x\,x'$	142	12
$b\,a$	150	00

Combinations: $o\,a$; $o\,a\,x$; $o\,a\,b\,x$; $o\,a\,v$.

Melts readily before the blowpipe on charcoal. The bead crystallizes on cooling, from which property the name is derived. With soda it is reduced. On the addition of nitrate of oxide of silver to the nitric solution, a precipitate of chloride of silver is formed.

Phosphoric acid	15·79
Oxide of lead	73·91
Chlorine	2·62
Lead	7·68
$3\dot{\mathrm{P}}\mathrm{b}^{3}\overset{\cdot\cdot\cdot\cdot\cdot}{\bar{\mathrm{P}}}+\mathrm{Pb}\bar{\mathrm{C}}\mathrm{l}$.	100·00

Part of the phosphoric acid is often replaced by arsenic acid.

Pyromorphite occurs crystallized, botryoidal, aggregated, massive and incrusting. Pseudomorphous crystals of galena in the form of this substance were formerly met with at Wheal Hope, and were known as *blue lead.*

LOCALITIES.—*England.* Cornwall; at Wheal Penrose, near Helstone; Wheal Golden, near St. Agnes; Wheal Alfred, and Penberthy Croft mine.

Devon; at Beeralston, of a grey colour.

At Grassington, in Yorkshire.

At Teesdale, Grasshill mine, Netherdale, and Allendale in Durham.

Derbyshire; in green and yellow crystals, at Bonsall Moor, and at Brassington; also in small green crystals on cawk, near Wirksworth.

Cumberland; of a rich golden-yellow colour, with the arseniate, at Mexico mine, near Roughten Gill; also at Brandygill and Driggath mines.

Lately in brilliant translucent hair-brown crystals on quartz, much resembling the variety from Bleistadt, in Bohemia, at a mine near the Devil's Bridge, in North Wales.

Scotland.—Green and yellow, at the Strontian mine, in Argyleshire. Formerly at Leadhills, of the most brilliant red and orange colours. These varieties, in which there is a small quantity of oxide of chrome, were not distinctly crystallized, but rather mossy and granular; a specimen in Dr. Heddle's collection, however, which in colour surpasses the chromate, is in large crystals.

Sparingly at Laxey mine, Isle of Man.

Ireland.—At Glenmalure, Co. Wicklow; formerly in fine crystals of a clove-brown colour, coated with others of a yellowish-green. In small hexagonal prisms, on ochreous sandstone, at a mine in Lord Londonderry's Park, Co. Derry. In the Island of Sark.

224. MIMETITE.—Arseniate of Lead, *Phillips*; Plomb-Arseniaté, *Hauy*; Mimetésite, *Beudant*; Mimetesit, *Breithaupt, Hausmann, Naumann, v. Kobell*; Mimetit, *Haidinger*; Kampylite, *Breithaupt.*

Rhombohedral. Form, angles and modifications the same as in pyromorphite, with which it is isomorphous. British forms: *a o*; *o a x*; of kampylite, *o a*; *o a x*; *o a x b*. Fracture imperfect, conchoidal to uneven. Translucent to opaque. Lustre resinous to adamantine. Colour straw-yellow, wax-yellow to brown, reddish-brown, orange-yellow, red. Streak white. Brittle. H. 3·5 to 4; Gr. 7·19 to 7·25. Gr. of kampylite, 7·218, according to Rammelsberg.

Before the blowpipe on charcoal emits fumes of arsenic acid, and yields a bead of lead. Fused in the forceps it crystallizes on cooling. With fluxes its behaviour is that of oxide of lead. Soluble in nitric acid and in caustic potash.

Analyses of Mimetite: *a*, from England, by Kersten; *b*, from Cornwall, by Dufrénoy; *c*, from Johann-Georgenstadt, by Wöhler:—

	a.	*b.*	*c.*
Arseniate of oxide of lead . .	89·110	84·55	82·74
Phosphate of oxide of lead . .	...	4·50	7·50
Chloride of lead	10·074	9·05	9·60
Phosphate of lime	0·682	...	...
Fluoride of calcium	0·130	...	...
	99·996	98·10	99·84

Did this species consist only of arseniate of oxide of lead and chloride of lead, the formula by which its composition would be expressed, would be $\mathrm{Pb}\text{Ꞓ}\mathrm{l}+3\dot{\mathrm{P}}\mathrm{b}^3\overset{\cdot\cdot\cdot}{\ddot{\mathrm{A}}}\mathrm{s}$; with arseniate of lead, 90·66; chloride of lead, 9·34; but as the arsenic acid is replaced very frequently by phosphoric acid in indeterminate quantities, the formula would be more correctly given in the following manner:—

$$\mathrm{Pb}\text{Ꞓ}\mathrm{l}+3\mathrm{Pb}^3\begin{cases}\overset{\cdot\cdot\cdot}{\ddot{\mathrm{A}}}\mathrm{s}\\ \overset{\cdot\cdot\cdot}{\ddot{\text{Ᵽ}}}\end{cases}$$

In attached crystals, or in aggregated and curved crystallized groups. Also botryoidal, compact and earthy.

Localities.—*England.* Cornwall; formerly at Wheal Unity, in Gwennap, in thick light-brown translucent crystals, some above three-quarters of an inch long. At North Downs mine, near Redruth. At Endellion. At Wheal Gorland. At Wheal Alfred.

Cumberland; in wax-yellow crystals, well defined, at Roughten Gill. At Mexico mine, on the road from Hesket Newmarket to Roughten Gill. The variety in barrel-shaped crystals, known as *kampylite* (from *καμπύλος, curved*), occurs at Drygill in large quantities; of various colours, yellowish to brown and brownish-red. Also at Brandygill, Carrock Fells, and at Saddleback, near Keswick.

Devonshire; at Beeralston.

Durham; at Allendale, Grasshill and Teesdale.

Yorkshire; at Grassington.

Scotland.—Formerly, at Leadhills and Wanlock Head, in small crystals (*a o*) of a brilliant yellow colour, and coating other minerals.

At Drygill it is met with in sufficient abundance to be worked to some extent as an ore of lead. Mimetite from this locality is also employed directly in the manufacture of flint-glass, to which it imparts a peculiar brilliancy.

The name mimetite is derived from *μιμητὴς, imitator,* from this species so completely resembling pyromorphite.

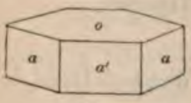
Note.—In Poggendorff's *Annalen* for 1854, part 91, p. 316, an analysis of the Cumberland *kampylite*, by Professor Rammelsberg, is given: it contained,—

Chlorine	2·41
Lead	7·04
Oxide of lead	68·89
Lime	0·50
Arsenic acid	18·47
Phosphoric acid	3·34
	100·65

Rammelsberg also states that this variety differs from others by having a larger amount of the phosphate of oxide of lead, of which it has nearly 1 atom against 3 atoms of the arseniate of oxide of lead; the proportion from the Johann-Georgenstadt locality, according to Wöhler's analysis, being as 1 to 10.

225. VANADINITE.—Vanadinite, *Dana*. Vanadiate of Lead.

Hexagonal. Isomorphous with pyromorphite. Fracture conchoidal. Lustre greasy. Feebly translucent to opaque. Light-yellowish; bright yellow to chestnut-brown, and dark-brown. Streak white. H. 3; Gr. 6·83.



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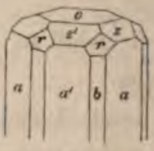


2

z o	120° 28′
r o	124 11
a a′	120 00
a o	90 00
a′ b	150 00

Combinations: *a o*; *a o b*; *a o z*; *a o b z r*.

Decrepitates violently before the blowpipe; very easily fusible; reducible on charcoal with emission of sparks. With salt of phosphorus gives in the oxidating flame a glass which is reddish-brown while hot, but which becomes yellowish-green on cooling. In the reducing flame the glass is of a beautiful chrome-green. On the addition of nitrate of silver to the nitric solution, chloride of silver is precipitated.

Analyses: *a*, of a specimen probably from Leadhills, by Damour; *b*, from Wanlock Head, by R. D. Thomson:—

	a.	*b.*
Vanadic acid	15·86	23·44
Oxide of lead	63·73	66·33
Lead	6·62	7·06
Chlorine	2·26	2·45 HCl
Oxide of zinc	6·35	...
Oxide of copper . . .	2·96	...
Water	3·80	...
	101·58	99·28

The formula is still doubtful; $\mathrm{Pb\bar{C}l} + 3\dot{\mathrm{P}}\mathrm{b}^3\dddot{\mathrm{V}}$, which is similar to the formulæ for the phosphate and arseniate with which this species is isomorphous, gives vanadic acid, 19·54; oxide of lead, 70·68; lead, 7·29; chlorine, 2·49; or vanadiate of lead, 90·22; chloride of lead, 9·78: while $(\mathrm{Pb\bar{C}l} + 2\dot{\mathrm{P}}\mathrm{b}) + 2\dot{\mathrm{P}}\mathrm{b}^3\dddot{\mathrm{V}}^2$, with vanadic acid, 21·19; oxide of lead, 68·19; lead, 7·91; chlorine, 2·71, certainly agrees better with the results of the second analysis, on which we conceive most dependence is to be placed, on account of an apparent admixture of foreign matter in the specimen analysed by Damour. It may be remarked that that part of the second formula within brackets is the composition of the species Mendipite.

The Vanadinite from Zimapan, analysed by Berzelius, is a different species both in composition and appearance.

Has been found both formerly and again lately, among the old heaps at the Hegh-pirn of the Susannah mine at Wanlock Head, in Dumfriesshire, on common and cupreous calamine; very rarely distinctly crystallized, usually occurring in small globular aggregations. The largest crystals not more than a quarter of an inch across. Very perfect ones are in Mr. Brown of Lanfine's, and in Dr. Heddle's collections, some presenting the form given in figure 2.

This species has been found at Wanlock Head in crystals, one extremity of which consists of phosphate of lead; Heddle infers from this perfect isomorphism that vanadic acid may be found to be V^2O^5, and not VO^3. Vanadinite also occurs in plates and in pseudomorphs after galena.

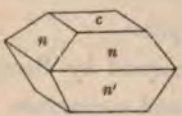
There is no truth in the statement that this species has been met with in Wicklow.

Dr. Heddle gives the following ready test for this mineral: if nitric acid be dropped upon the crystals, they become first deep red from the separation of vanadic acid, then of a brilliant yellow upon its solution.

The name Vanadium given to the characteristic metal occurring in this mineral is derived from *Vanadis*, one of the synonyms of Venus in Swedish mythology.

226. STOLZITE.—Tungstate of Lead.

Pyramidal. Primary form a right square prism, but it usually occurs in modified square octahedrons. Cleavage indistinct parallel to *n*, rather more distinct parallel to *c*. Fracture conchoidal. Transparent, translucent on the edges, opaque. Lustre resinous to greasy. Yellowish, brownish, grey. H. 3; Gr. 8·0 to 8·1.



n n 99° 45′
n n′ 131 25

Before the blowpipe on charcoal readily fusible to a metallic shining crystalline bead. Reducible with soda. Soluble in nitric acid, leaving a lemon-yellow residue of tungstic acid.

$\dot{\mathrm{P}}\mathrm{b}\,\dddot{\mathrm{W}}$	Oxide of lead . . .	48·46
	Tungstic acid . . .	51·54
		100·00

First noticed in this country by Mr. Greg, in very minute but measureable crystals, on macled crystals of black carbonate of lead from Force Craig lead-mine, near Keswick. The crystals were of a greyish-white colour, brilliant, and of the form given in the accompanying figure.

The name Stolzite was given by Professor Haidinger in compliment to Dr. Stolz of Töplitz, who first established the chemical constitution of this species.

227. WULFENITE, *Haidinger*; Molybdate of Lead, *Phillips*.

Pyramidal. Fracture conchoidal, uneven. Transparent on edges, translucent. Lustre resinous. Colourless, yellow, grey, brown. Streak white. Brittle. H. 3·0; Gr. 6·3 to 6·9.

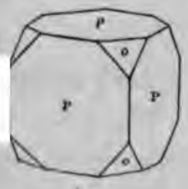
Decrepitates when heated, and becomes darker; on cooling the colour disappears. Melts before the blowpipe on charcoal, and sinks into the charcoal, leaving globules of metallic lead on the surface. Partially soluble in muriatic acid; the solution is green.

$\dot{Pb}\dddot{Mo}$; molybdic acid, 38·57; oxide of lead, 61·43.

It is not certain whether this may rank as a British species or not. In Thomson's 'Mineralogy,' vol. i. p. 565, under the head of Oxychloride of Lead, are the following remarks, speaking of a specimen in the Stockholm Academy: "It was ticketed *lead-spar*, from Mendip, near Churchhill in Somersetshire; it was chiefly carbonate of lead, but it contained two portions of a yellower colour than the rest, which attracted the peculiar attention of Berzelius. *One* of these, on being examined by the blowpipe, proved to be *molybdate of lead*. The other portion was an oxychloride of lead."

228. GALENA.—Galena, *Brooke* and *Miller*, *Phillips*; Plomb Sulfuré, *Hauy*; Galène, *Beudant*; Bleiglanz, *Hausmann*, *Naumann*; Glanz, *Haidinger*; Galenit, *v. Kobell*.

Cubic. Cleavage perfect parallel to P. Twin crystals, twin-e *o.* revailing forms are the cube and a combination e c octahedron. Lustre metallic. Opaque. Colour streak lead-grey. Fracture conchoidal, but difficult to owing to the readiness with which it cleaves. Often rnished, especially on the faces of the octahedron. Rather tile. H. 2·5 ; Gr. 7·4 to 7·6.



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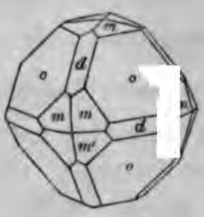

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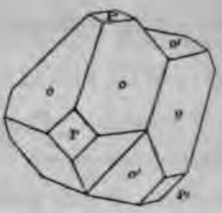

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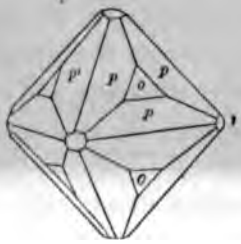

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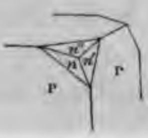


5

P P	90° 00′	*d o*	144° 44′	*o o*	109° 28′
P *o*	125 16	*n o*	160 32	P *n*	144 44
P *d*	135 00	*o m*	150 30	P *m*	154 46
d d	120 00	*p o*	164 12	P *p*	109 28

Combinations: P; *o*; P*o*; P*od*; P*n*; P*op*; P*dm*; P*on*; P*odm*; P*om*.

In the open tube yields a sublimate of sulphur and of sulphate of oxide of lead. Decrepitates on charcoal, and after the sulphur is driven off is reduced to a bead of lead, from which a globule of silver may be frequently obtained by cupellation. Partially soluble in nitric acid, with evolution of nitrous acid and separation of sulphur.

Analyses: *a*, by Thomson; *b*, from Inverkeithing, by Robertn:—

	a.	*b.*
Lead	85·13	84·63
Iron	0·50	. . .
Sulphur	13·02	13·21
Pb.	98·65	97·84

The formula requires lead, 86·55; sulphur, 13·45.

Very much of the galena raised in the United Kingdom is found to contain silver enough to leave a profit upon its extraction, the cost of which is said to be covered by a yield of only 3½ ounces of silver to the ton of lead, and possibly by means of the new zinc-process even a less yield than that will be now turned to account; after this extraction the lead itself is much more valuable, the silver rendering it hard and brittle. The variety termed fine-grained is generally more prized by the miner for the silver it contains than that of a more distinctly lamellar structure. It occasionally contains antimony, and at one locality in Ireland is found to contain cobalt.

Galena occurs very abundantly in rocks of the most different formation associated with chalcopyrite, calamine, brown oxide of iron, pyrites, blende, quartz, and barytes.

Cornwall and Devonshire; in veins in clay-slate.

Cumberland, Durham, Northumberland, Derbyshire, and Flintshire; in veins in limestone.

Shropshire, and most of the counties in Wales, in slate.

At Leadhills in Lanarkshire; Wanlock Head in Dumfriesshire, and Monaltrie in Aberdeenshire, in granite. At Strontian in Argyleshire, in gneiss. At Cumberhead in Lanarkshire, in the Lothians and in Fifeshire, in the sandstones of the coal formation. In limestone in Isla; in gneiss in Coll. In the Orkneys, in old red sandstone.

Occurs in attached, and rarely in imbedded crystals; most commonly in coarse or fine-grained aggregations, or disseminated, and sometimes in the form of a film. *Pseudomorphous* after pyromorphite.

Galena is so generally distributed that it seems desirable to mention only those districts and localities where the finest crystals or most interesting mineralogical specimens have been or are met with; referring those who require more detailed information upon this point to the list of the principal lead-mines of the United Kingdom, drawn up by Mr. Robert Hunt, Keeper of Mining Records at the Museum of Economic Geology, pubblished in the 'Mining Almanac' for 1850 and 1851.

LOCALITIES.—*England.* Cornwall; in very perfect crystals, combining the cube and octahedron, lately, at Huel Mary Ann, Menheniot. At East Huel Rose, Newlyn. In large cubes at Tresavean and at Poldice, Gwennap. At Penrose in Sithney. At Garras near Truro. The variety known by the name of *blue lead* was found at Huel Hope in long, irregular, six-sided, pseudomorphous crystals, after pyromorphite: held in the flame of a candle, it burns like the supersulphuret of lead of Johnston. Lately, at Herodsfoot mine, near Liskeard.

Devon; at Beeralston.

Leicestershire; in fine crystals at Ticknil Hall; recently, at some localities, antimonial. The *antimonial* galena occurring in Tuscany, is found to contain also copper, iron, and zinc; having seen no analysis of the Leicestershire mineral, we are unable to say what are its precise constituents.

Derbyshire; in fine crystals at Eyam, the octahedral planes remarkable for the brilliance of their tarnish. Occasionally in this county in coal.

In curious flattened octahedral crystals in limestone, at Durdham Down near Bristol.

Yorkshire; a fine cleavable variety, at Craven; in iridescent crystals at Grassington. At Allenheads and Nenthead.

Cumberland; at Alston, in very fine iridescent octahedrons, with pearl-spar; in large octahedrons, with barytes, at Dufton. At this latter locality it frequently contains free sulphur interspersed throughout its mass, and occasionally the planes of the crystals are studded with minute crystals of sulphur. In large cubic crystals at Brownly Hill.

Perhaps the largest crystals of galena ever found have occurred recently at the Laxey and the Foxdale mines in the Isle of Man; they are sometimes as much as 10 inches across. They are usually of the form represented in figure 1, but combinations of the cube, octahedron, and dodecahedron are also met with.

Wales.—Auro-argentiferous, at Cwmheisian, Merionethshire. From a recent trial with Burdan's apparatus, the quantity of gold appears to be 1 oz. 16 dwts. 18 grs. of gold, of 20 carats fine, to the ton of ore. In fine crystals at Goginan mine, Cardiganshire.

Scotland.—In fine octahedrons, at Inverkeithing in Fifeshire, but not lately. Antimonial, at Leadhills.

Ireland.—Very rich for silver, at Shallee, Tipperary. A variety containing cobalt occurred formerly in the parish of Faithleg in Waterford. What the amount of cobalt in the galena in question is, we do not know, but the cobaltic galena met with in the Hartz contains 0·94 per cent. of cobalt.

Slickenside, or *specular* galena, a variety which, when first struck by the miner's pick, is said to explode with dangerous violence, occurs in characteristic specimens at the following mines:—

In Cornwall at Huel Tamar, at Carnbrae, and at Huel Friendship near Marazion. At Grassington in Yorkshire. At the Odin mine in Derbyshire; and occasionally in the Alston Moor mines. In Ireland at Knockmahon in Waterford; at Glendasane, in Wicklow.

Note.—The following account of the lead trade of the United Kingdom for 1855, drawn up by Mr. Robert Hunt, Keeper of Mining Records at the Museum of Economic Geology, is taken from Hogg's 'Business Man's Note-book' for 1857:—

Produce of Lead Ore, Lead, and Silver, in the United Kingdom, for the Year 1855.

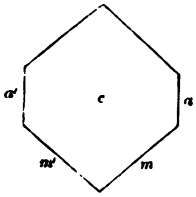
	Lead Ore.		Lead.		Sil
ENGLAND.	Tons.	cwts.	Tons.	cwts.	Oun
Cornwall	8,962	19	5,882	8	211,3
Devonshire	4,035	18	2,292	10	89,
Shropshire	3,310	16	2,420	0	...
Derbyshire	8,527	0	5,798	15	...
Yorkshire	9,378	8	6,369	6	273
Westmoreland	319	18	241	17	140
Cumberland	9,627	13	6,929	17	62,879
Durham and Northumberland	22,107	18	16,309	19	75,435
WALES.					
Glamorganshire	12	0	9	0	36
Carmarthenshire	1,137	0	763	0	868
Brecknockshire	24	0	20	0	...
Cardiganshire	7,043	3	5,014	8	28,079
Radnorshire	24	3	16	0	...
Montgomeryshire	1,087	13	847	0	1,269
Merionethshire	48	0	38	0	266
Denbighshire	2,401	0	1,929	0	1,180
Flintshire	6,273	5	4,926	13	25,823
Carnarvonshire	155	17	111	0	...
SCOTLAND	1,587	0	1,159	12	4,947
IRELAND	2,405	15	1,732	0	7,252
ISLE OF MAN	3,573	5	2,725	0	51,597
Sundries	208	5	156	0	606
Total	92,330	16	73,091	5	561,906

Estimate of Silver produced from the Mines of Great Britain and Ireland in 1852.

		Av. pro. of silver in each ton of lead.	Ounces of silver in each district.	Value at 5 shillings per ounce.
Cornwall	*Ounces*	35	250,008	£62,502
Devonshire		40	91,340	22,835
Cumberland		9	52,893	13,223
Durham, Northumberland, and Westmoreland		12	191,736	47,934
Cardiganshire, Carnarvonshire, and Carmarthenshire		15	91,680	22,920
Flintshire and Denbighshire		7	47,138	11,784
Montgomeryshire and Merionethshire		6	5,562	1,390
IRELAND		10	32,220	8,055
SCOTLAND		8	19,048	4,762
ISLE OF MAN		20	36,700	9,675
Total			818,325	£205,080

229. JAMESONITE, *Haidinger, Dufrénoy, Phillips.*

Prismatic. Primary form a right rhombic prism. Cleavage *c* very perfect; *m*, *a* less so. Opaque. Lustre metallic. Colour and streak steel-grey. Sectile. H. 2·0 to 2·5; Gr. 5·7.



a c	90° 00′
m c	90 00
m a	129 20
m m'	101 20

In the open tube affords white fumes of oxide of antimony; is decomposed by warm muriatic acid; decrepitates when heated. Before the blowpipe on charcoal easily melts, depositing a sublimate of the oxide of lead and antimony, and leaving a slag containing iron.

Analyses: *a*, from Valencia, by Schaffgotsch; *b* and *c*, from Cornwall, by H. Rose:—

	a.	*b.*	*c.*
Lead	39·97	40·75	38·71
Iron	3·63	2·30	2·96
Copper	...	0·13	0·21
Zinc	0·42	...	0·74
Bismuth	1·06	...	...
Antimony	32·62	34·40	34·90
Sulphur	21·78	22·15	25·53
	99·48	99·73	103·05

Formula, $2\overset{,}{\mathrm{P}}\overset{,,,}{\mathrm{Sb}}+\overset{,}{\mathrm{P}}\mathrm{b}$; with lead, 43·6; antimony, 36·2; sulphur, 20·2.

Occurs in acicular crystals, or in parallel or diverging groups, more frequently in fibrous masses.

Localities.—Cornwall; in the neighbourhood of Padstow; at Huel Lee near Calstock; Port Quin Cliffs near Endellion; at Port Isaac, Pendogget; and at Trevinnock, near Endellion, with Bleinierite.

230. GEOCRONITE, *Svanberg*; Kilbrickenite, *Apjohn*; Schulzite, *Haidinger*.

Prismatic. Cleavage $m\, m' = 119°\, 44'$. Fracture conchoidal, uneven. Usually massive; also granular or earthy. Lustre metallic. Colour and streak lead-grey. Brittle. H. 2·5 to 3; Gr. 5·8 to 6·5.

Melts easily before the blowpipe, affording the reactions of antimony and lead. Slowly soluble in warm muriatic acid.

Analyses: *a*, from Sahla, in Sweden, by Svanberg; *b*, from Mérédo, by Sauvage; *c*, from Kilbricken, by Apjohn:—

	a.	*b.*	*c.*
Lead	66·45	64·89	68·87 (Sp. Gr. 6·407)
Copper	1·51	1·60	. . .
Iron	0·42	. . .	0·38
Zinc	0·11	. . .	. . .
Antimony	9·58	16·00	14·39
Arsenic	4·69	. . .	. . .
Sulphur	16·26	16·90	16·36
	99·02	99·39	100·00

Formula, $\overset{\prime}{\mathrm{Pb}}{}^5(\overset{\prime\prime\prime}{\bar{\mathrm{S}}\mathrm{b}},\overset{\prime\prime\prime}{\bar{\mathrm{A}}})$; with lead, 66·8; antimony, 16·7; sulphur, 16·5.

The mineral analysed by Apjohn, and called by him Kilbrickenite, is supposed by Rammelsberg to be geocronite; apparently with reason.

Found in the United Kingdom, at Kilbricken, Co. Clare in Ireland.

Derived from γῆ, *the earth*, Κρόνος, *Saturn*, the alchemistic name for lead.

231. MENDIPITE.—Kerasin, *Beudant*; Mendipit, *Haidinger*; Berzelite, *Levy*.

Prismatic. Primary form a right rhombic prism, with cleavage parallel to M M′, giving the angle 102° 36′. Fracture uneven, conchoidal. Translucent on edges. Lustre adamantine, inclining to pearly on the cleavages. Yellowish-white, with a tinge of pink sometimes. H. 2·5 to 3·0; Gr. 7·1.

Decrepitates before the blowpipe, but easily melts into a bright yellow globule. On charcoal is readily reduced, giving off acid fumes. Readily dissolved in nitric acid.

Analyses: *a*, by Rhodius, from Kunibert mine near Brilon; *b*, by Berzelius, from Churchill:—

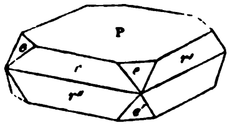
	a.	*b.*
Oxide of lead	60·10	60·18
Chloride of lead	39·07	39·82
	99·17	100·00

$\mathrm{Pb}\bar{\mathrm{C}}\mathrm{l}+2\dot{\mathrm{P}}\mathrm{b}$; with oxide of lead, 61·6; chloride of lead, 38·4.

This rare species was formerly found in small quantity near Churchill, in the Mendip Hills, Somersetshire, and occurred in small radiated and crystalline masses along with galena, black earthy manganese, and hematite.

232. MATLOCKITE.—Matlockite, *Greg, Brooke* and *Miller*.

Pyramidal. Primary form a right square prism. Cleavage P imperfect. Fracture uneven and slightly conchoidal. Transparent, translucent. Lustre adamantine, P sometimes slightly pearly. Yellowish, with sometimes a greenish tinge. H. 2·5 to 3; Gr. 7·21.



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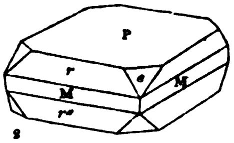


2

M M	90° 00′	P *e*	119° 34′	*r r″*	136° 19′
P M	90 00	*e e′*	120 52 (121·02 Kengott)	*r r′*	97 58
P *r*	111 50	*e r*	138 59		

Combinations observed: P M *r*; P M *r e*; P *r e*.

Decrepitates before the blowpipe. On charcoal easily reduced, giving off acid fumes. Readily dissolved in nitric acid, the solution indicating the presence of chlorine in abundance.

Analyses: *a*, by Dr. R. A. Smith; *b*, by Rammelsberg, both from Cromford:—

	a.	*b.*
Chloride of lead	57·177	52·45
Oxide of lead	44·300	46·42
Water	0·072	...
	101·449	98·87

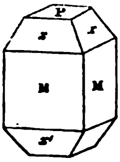
$\mathrm{Pb}\bar{\mathrm{C}}\mathrm{l}+\dot{\mathrm{P}}\mathrm{b}$; with chloride of lead, 55·5; oxide of lead, 44·5.

This basic chloride of lead, with which, as a natural species, mineralogists have only recently become acquainted through the zeal of Mr. Wright of Liverpool, has been known to chemists for some time, inasmuch as Pattison's oxychloride of lead, which is much recommended as a substitute for white lead paint, is identical in composition with this mineral.

Matlockite was found lately by Mr. Wright in decomposed galena, associated occasionally with Cromfordite, in one of the air-shafts of an old level near Cromford in Derbyshire. Crystals always tabular, seldom large, though a crystal in the possession of Mr. Nevill measures nearly 2 inches across. The crystals are generally thin, frequently aggregated, or superimposed on each other, and occasionally slightly curved. Mr. Wright found but few good specimens of this mineral, and holds out slight hopes that more will be found. It may not be uninteresting to know that a specimen of Matlockite has been in the collection of the British Museum, unrecognized as a distinct species, for many years. This mineral bears some resemblance to Leadhillite, or the Sulphato-tri-carbonate of lead.

233. CROMFORDITE.—Murio-carbonate of Lead, *Phillips*. Horn Lead. Phosgenite, *Brooke* and *Miller*; Plomb Carbonaté Muriatifère, *Hauy*; Kerasin, *v. Kobell*; Bleihornerz, *Naumann*; Hornblei, *Hausmann*; Phosgenit, *Breithaupt*, *Haidinger*.

Pyramidal. Primary form a right square prism. Cleaves readily parallel to P, M and *a*. Fracture conchoidal. Transparent, translucent, opaque. Lustre adamantine, inclining to waxy. Colourless, white, passing into grey, yellow, greenish, brown. Streak white. Brittle. H. 2·5 to 3; Gr. 6 to 6·2.



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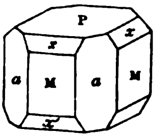

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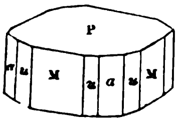

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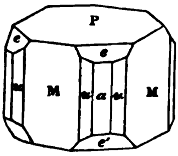

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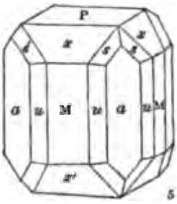


5

M M	90° 00′	P *s*	112° 24′	M *s*	151° 26′	*s a*	145° 47′
P M	90 00	M *a*	135 00	*u a*	152 26	*s s*	131 10
P *a*	90 00	M *u*	161 34	*x x′*	113 48	*u a*	153 26
P *x*	123 08	M *x*	146 54	*x x*	107 21	*e e′*	94 39

The following combinations have been observed in the collection at the British Museum, and in those of Messrs. Turner, Greg, and Lettsom: P M; P M *x*; P M *a x*; P M *a e*; P M *a e u*; P M *a e x*; P M *a u x*; P M *e u x*; P M *a e u x*; P M *a u*; P M *a s u x*.

The form given in figure 5 represents the only specimen of this substance known to have been found in Cornwall. This is in Mr. Brooke's collection. A specimen having the same form, from Derbyshire, is in the collection of Mr. Greg.

Before the blowpipe it fuses readily in the oxidating flame to an opaque yellow globule, the surface of which, on cooling, assumes a somewhat crystalline appearance. In the reducing flame, on charcoal, gives off acid vapours, and yields a bead of lead. Soluble with effervescence in nitric acid. The solution gives abundant indications of the presence of chlorine.

Analyses: *a*, by Dr. R. A. Smith; *b*, by Rammelsberg:—

	a.	*b.*
Chloride of lead	51·78	50·93
Carbonate of oxide of lead .	48·22	48·45
	100·00	99·38

$\text{PbȻl}+\dot{\text{P}}\text{b}\ddot{\text{C}}$.

The above analyses may be resolved into,—

Lead	37·98
Oxide of lead	40·91
Chlorine	13·01
Carbonic acid	8·08
	99·98

Many years ago a few fine specimens of this rare mineral were met with in an air-shaft to a level at a mine between Cromford and Wirksworth in Derbyshire. Most of those specimens are preserved in the British Museum. No more were afterwards procured in consequence of the mine becoming flooded. A deeper level being then driven, the shaft in question became drained. Hearing of this, Mr. Brice Wright, an intelligent and zealous dealer in minerals, now residing in London, determined to take the matter up, and succeeded in making out, in 1851, the precise shaft in which the crystals had been originally met with. His further labours were rewarded by the discovery of a few fine specimens of this very rare species, in cavities of decomposed galena, here and there associated with Anglesite and Matlockite. The exact spot where the crystals were originally met with was then called the Bage mine, and is in the middle of a little village named Bole Hill. In speaking of the crystals of this mineral rediscovered, Mr. Wright says, "they are only found at certain places in the mine where decomposition of the galena has taken place. I have examined every mine in the neighbourhood, and have not met with a single crystal of this mineral, except at the spot referred to; and as the mine is no longer in work, I do not think it likely that this locality will furnish any more specimens."

Some of these crystals are exceedingly fine and large, being highly modified, transparent, and, in a few instances, 2½ inches long.

The unique Cornish specimen, already spoken of, figure 5, in the possession of the late Mr. Brooke, was found in gossan. Its exact locality is believed to be Huel Confidence, New Quay, in St. Columb Minor.

Mr. Wright has quite recently found this mineral, in minute crystals, with galena and quartz, at Lossiemouth lead-mine in Elgin, Scotland.

The names for this species being almost as numerous as the specimens which are known to exist of it, some explanation is necessary to justify our venturing to add still further to the list by calling it Cromfordite. V. Kobell's recent name, Kerasin, was, however, given by Beudant, many years ago, to another mineral, namely to Mendipite. Breithaupt's name, Phosgenit, which is that adopted by Brooke and Miller, is based upon a notion which is not only too fanciful to render it admissible, but is at the same time incorrect. The word Cromfordite is not open to either of these objections, and as it recalls the original locality of the mineral, it appears to us to fulfil well enough all that can be fairly looked for in a mineralogical name.

Order XVIII. ZINC.

234. CALAMINE.—Calamine, *Brooke* and *Miller*; Carbonate of Zinc, *Phillips*; Zinc Carbonaté, *Hauy*; Smithsonit, *Haidinger*, *v. Kobell*; Zinkspath, *G. Rose*, *Naumann*; Galmei, *Hausmann*.

Rhombohedral. R R′ 107° 40′. The crystals of this species, as met with at localities in the United Kingdom, are minute and usually indistinct, from the faces of the rhombohedron being rounded and their edges blunt. It usually occurs reniform, botryoidal, stalactitic, fibrous, granular, sometimes in crusts, occasionally massive. Cleavage rhombohedral. Colourless, but more frequently white, grey, yellow or brown; at a few British localities green. Fracture uneven, imperfect conchoidal. Lustre vitreous, inclining to pearly; the pseudomorphous crystals met with in Somersetshire are dull. Streak white. Brittle. H. 5; Gr. 4·1 to 4·5.

Infusible before the blowpipe. With solution of cobalt becomes of a fine green. Soluble with effervescence in hydrochloric acid. Soluble in caustic potash.

Analyses: *a*, from Somersetshire; *b*, from Derbyshire, both by Smithson:—

	a.	*b.*
Oxide of zinc	35·2	34·8
Carbonic acid	64·8	65·2
	100·0	100·0

$\dot{\mathrm{Zn}}\ddot{\mathrm{C}}$; with oxide of zinc, 64·81; carbonic acid, 35·19.

LOCALITIES.—*England.* Cornwall; at Wheal Mary.

Cumberland; at Roughten Gill, botryoidal, of a lavender colour, with barytes and arsenio-phosphate of lead. At Alston Moor; mammillated and in crusts, white, brown, and occasionally of a fine rich yellow. At Farnberry mine, Alston.

Derbyshire; near Wirksworth and Castleton. In the neighbourhood of Matlock, radiated, of a bluish-green colour. At the Rutland mine, botryoïdal, of a pale green. At Old Nestor mine, and at the Cumberland Cavern.

Northumberland; at Allenhead mine.

Somersetshire; at various places on the Mendip Hills, at some of which, in large pseudomorphous crystals after calcite.

Wales.—Cardiganshire; Cwmystwith. Denbighshire; at Llanymynech Rocks. Flintshire, near Holywell, crystallized in obtuse rhombohedrons, and at Halken Mountain.

Scotland.—At Leadhills.

Ireland.—Donegal; with copper ores near Ballyshannon. Galway; yellowish-green, mammillated and stalactitic, with blende at a copper mine.

This species is somewhat extensively used in this country for the direct formation of an alloy which of late years has in many instances been substituted for brass.

235. AURICHALCITE, *Böttger*, Pogg. xlviii. 495. Green Calamine, *Patrin*.

In acicular crystals forming incrustations, or in fibrous silky and diverging groups. Lustre pearly. Colour pale green, verdigris-green. Translucent. H. 2.

In the matrass yields water and grows brownish-black. In the inner flame forms a slag, yellow while hot, and white on cooling, depositing on the charcoal a sublimate of zinc. With borax intumesces and forms a green glass. Soluble with effervescence in muriatic acid.

Analyses: *a*, from Altai, by Böttger; *b*, from Matlock, by Connel:—

	a.	*b.*
Oxide of zinc	45·620	42·7
Oxide of copper . . .	28·357	32·5
Carbonic acid	16·077	27·5
Water	9·333	
	99·387	102·7

Formula, $(\dot{C}u^2\ddot{C}+\dot{\bar{H}})+(\dot{Z}n^3\ddot{C}+2\dot{\bar{H}})$; with oxide of zinc, 44·71; oxide of copper, 29·17; carbonic acid, 16·19; water, 9·93.

LOCALITIES.—Occurs in small groups of a pale green colour and laminated structure on a greyish-brown decomposed calc-spar, at the Rutland mine, near Matlock, in Derbyshire.

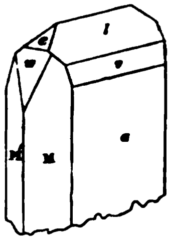
The Authors have lately noticed it in specimens brought by Mr. Wright from Roughten Gill, in Cumberland, accompanied with malachite, on a hard ochreous rock.

A single specimen of this mineral from Leadhills, accompanying Smithsonite, is in Dr. Heddle's collection.

236. SMITHSONITE.— Siliceous Oxide of Zinc, *Phillips*; Zinc Oxidé Silicifère, *Hauy*; Kieselzinkerz, *G. Rose*; Calamin, *v. Kobell*; Galmei, *Naumann*; Zinkglas, *Hausmann*.

Prismatic. Commonly with hemihedral terminations. Primitive form a right rhombic prism. Cleavage M, *e* both easily obtained, the former very perfect: *e, l, v, w* are frequently hemihedral faces; the other end of the crystal, when observable, which is rarely the case, terminates in four pyramidal planes *s*, which are also hemihedral. Fracture uneven. Colourless, white, grey, yellow, brown, green and blue, but usually not very deep in tint. Lustre vitreous, inclining to adamantine, on *a* pearly. Transparent to pellucid and opaque. Streak white. Brittle. Phosphoresces when rubbed. Crystals pyro-electric, a property possessed by most hemimorphous species, contrary electricity being manifested at their opposite ends. H. 5; Gr. 4·1 to 4·2.

In the matrass yields water. Before the blowpipe decrepitates somewhat, fuses only on the edges, and that not readily. With solution of cobalt becomes blue, with spots of green. Soluble in hydrochloric acid, forming a jelly of silica. Soluble in oxalic acid both before and after exposure to a red heat. In attached crystals forming diverging groups, botryoidal and investing, in columnar or granular masses, and compact.



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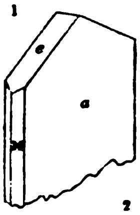

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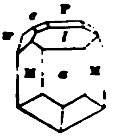


3

M	M'	103°	56'
M	*a*	128	03
a	*v*	145	23
a	*l*	115	47
a	*s*	129	25
P	M	90	00
P	*e*	148	20
P	*w*	118	23

Combinations: M*aes*; M*aelwes*; M*aelvwes*.

The face P (*c* of Brooke and Miller) has not been observed in Great Britain: figure 3 is a figure given in Naumann's 'Mineralogy.'

Analyses: *a*, from Leadhills, by Thomson; *b*, crystallized, from Moresnet, in Belgium, by Schmidt:—

	a.	*b.*
Oxide of zinc	66·8	66·48
Silica	23·2	24·44
Peroxide of iron	...	0·72
Carbonic acid	...	1·02
Water	10·8	7·02
	100·8	99·68

$2\dot{Zn}^3\ddot{Si}+3\dot{H}$; with oxide of zinc, 67·4; silica, 25·1; water, 7·5.

The amount of water in the analysis by Thomson is higher than that given by other chemists, being approximately two equivalents to one; he assumes that the species contains in truth three atoms, a portion of which is usually lost by t mineral becoming weathered.

When massive or botryoidal this species may at first sight b confounded with calamine. The former, however, on exposure to the blowpipe flame becomes blue, with green spots only here and there.

Localities.—*England.* Cumberland; in fine white acicular crystals at Roughten Gill, Caldbeck Fells. At the same locality in crystalline mammillary crusts of a magnificent sky-blue colour, likewise of a fine green, also compact. White, coating blende at Alston Moor.

Derbyshire; in very perfect brilliant crystals, of the form of figure 1, at the Rutland mine, near Matlock, and at Masson Hill. In the neighbourhood of Matlock, fibrous and mammillated, of a greyish-white or yellow. Formerly, near Matlock, in pseudomorphous crystals, after that form of calcite known as dog-tooth spar.

The crystals are small, but beautifully perfect, at Castleton.

Durham; at Nenthead.

Somersetshire; on the Mendip Hills, as at Shipham, near Cross, of various colours, generally brownish-yellow; also stalactitic and botryoidal.

Near Bristol; with galena.

Wales.—In Flintshire, near Holywell.

Scotland.—At Leadhills, formerly, in white acicular crystals like figure 2. At Wanlock Head, stalactitic and botryoidal, of a pale greenish-white, with Vanadinite. Also of a fine turquoise colour, investing cubes of galena; occasionally in the forms of vanadiate of lead and galena; rarely of a splendid green.

The name Smithsonite is given to this species in honour of the chemist Smithson. Several continental mineralogists give this name, however, to the carbonate of zinc, the calamine of this volume; but as Smithson was one of the first whose labours were directed to explain the constitution of what are now termed silicates, it is with a silicate that his name should in propriety be associated.

237. GOSLARITE, *Haidinger*. Zinc Vitriol. Sulphate of Zinc. White Vitriol.

Prismatic. Crystals commonly produced artificially. Usually occurs massive, stalactitic or botryoidal. Transparent, translucent. Colourless, white; stained pale red, grey or green. Lustre vitreous. Taste astringent, metallic and nauseous. Brittle. H. 2·0 to 2·5; Gr. 1·9 to 2·1.

In the matrass yields water, and when heated to redness with charcoal sulphurous acid is given off, covering the charcoal with a white coating of oxide of zinc. Easily soluble in water.

Analyses: *a*, from Cornwall, by Schaub; *b*, from Goslar, by Klaproth:—

	a.	*b*.
Sulphuric acid . . .	21·60	22·0
Water	46·50	50·0
Oxide of zinc	25·66	27·5
Oxide of copper . . .	1·00	. . .
Oxide of iron	0·17	0·4
Oxide of manganese . .	4·33	0·7
	99·26	100·6

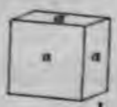
Formula, $\dot{Z}n\dddot{S}+7\dot{\bar{H}}$; with sulphuric acid, 27·87; oxide of zinc, 28·24; water, 43·89.

Occurs principally in the deserted galleries of old mines, and is supposed to arise from the decomposition of blende, with which it is frequently associated.

LOCALITIES.—Occasionally in the Cornish mines; in acicular crystals in a lode which traverses the Tresarvean and Trethellan mines, in Gwennap, near St. Day. Also at Holywell, in Flintshire.

238. BLENDE, *Haidinger, Phillips*; Zinc Sulfuré, *Hauy*.

Cubic. Cleavage *d* very perfect. Twin-face *o*. Fracture conchoidal. Transparent to opaque. Lustre adamantine. Colour reddish-brown, brown, yellow, black, green. Brittle. H. 3·5 to 4·0; Gr. 3·9 to 4·2.



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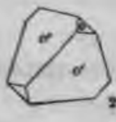

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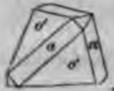

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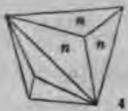

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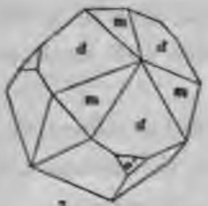

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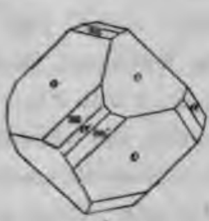

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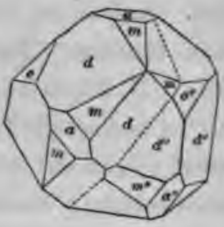

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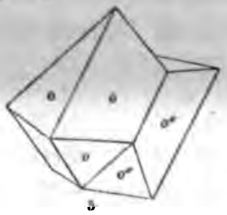

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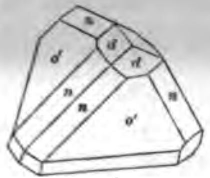

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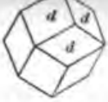


10

a a	90° 00′	*d a*	135° 00′	*n d*	150° 00′
d d	120 00	*d o*	144 34	*m a*	154 46
o o	109 28	*n a*	144 34	*m o*	150 30
o o′	70 32	*n o*	140 32	*m d*	148 31
o a	125 16				

British forms: *a*; *d*; *o*; *a o o′*; *o o′*; *d o′*; *m*; *m d*; *o′ n d*; *o m a*; *m d o′*; *m d a o′*.

The forms *m*, *o* usually hemihedral, with inclined faces.

Decrepitates violently when heated. Before the blowpipe on charcoal is fusible with difficulty on the edges. With soda is reduced. In powder soluble, with the exception of the sulphur, in concentrated nitric acid.

Composition, Źn; zinc, 67·03; sulphur, 32·97; usually contains a little iron, and sometimes 2 or 3 per cent. of cadmium. A blende from England afforded Berthier $\acute{Z}n$ 91·8, $\acute{F}e$6·4=98·2. In attached crystals, also in granular, fibrous, lamellar and botryoidal masses.

It is a very common mineral, occurring usually with galena, copper pyrites, and silver ores. It is not used as an ore of zinc, on account of the difficulty and expense of reducing it. Cleavable masses have been produced artificially by fusing together zinc and sulphur.

LOCALITIES.—*England.* Cornwall; in mines near St. Agnes, with the forms of figures 1, 2, and 3; at Botallock mine, St. Just; at West Huel Darlington; Huel Unity, St Day; Huel Friendship near Tavistock; near Truro and St. Austell, at mines recently; Huel Falmouth, St. Kea; in Perranzabuloe; at Huel Crofty, Camborne; white, mammillated, and having a fibrous structure, at Huel Unity and Fowey Consols; at the latter mine also, a white transparent variety (*Cleiophane*) has occurred recently. It is worthy of remark, that most of the simpler forms have occurred in Cornwall, as those represented by figures 1, 2, 3, 4, 5, 8, and 10. At Fowey Consols a cadmiferous blende occurs.

Cumberland; at Force Craig and Woodend mine near Keswick; near Alston, as at Nenthead, Ogill Burn, Old Hagg's mine, Garrigill, Coal Cluff, Rotherup Fell, and Sandbed mine; at Caldbeck Fells. The Cumberland and Alston forms are represented by figures 7 and 9.

Durham; at Allenhead.

Derbyshire; at Castleton, and near Matlock, with galena and mountain limestone.

Shropshire; at the Snailbeach mines.

Flintshire; at Holywell and Whitford.

Cardiganshire; at the Lisburne mines. With gold and galena at Caio, Carnarvonshire; and at Dolgelley, Merionethshire.

At the Laxey lead-mines, in the Isle of Man.

Scotland.—Dumfriesshire; at Leadhills. With galena, and with the form of figure 3, in the Edinburgh coal-fields. At Clifton lead-mine, near Tyndrum, in Perthshire. At Coranter, near Strontian, in Argyleshire. In an old lead-mine near Stromness, Orkney.

Ireland.—Co. Dublin; at Clontarf. Co. Down; at Newtownards, in twin-crystals. At the Ardtully copper-mines, Kenmare, Co. Kerry.

Note.—The production of zinc in England is on the increase. The following statistics have been borrowed from Hogg's 'Business Man's Note-Book,' published in 1857:—

ZINC ORES.

	Calamine.		Blende.	
	Tons.	cwt.	Tons.	cwt.
Alston-Moor mines	182	3	662	1
Pencorse Consols	...	...	770	0
Silver Brook, Ilsington	...	...	342	18
Lisburne mines	...	...	315	0
Cefn Brwyno	...	...	46	14
Foxpath	...	...	26	5
Rheidol United	...	...	66	5
Caegynon	...	...	9	9
Nantycria	...	...	128	0
Minera mines	...	...	854	6
Talargoch mine, Dyserth near Rhyl	...	...	851	10
Greenwich Hospital mines	...	...	550	0
Laxey mines	...	...	3989	18
Nantycar	...	...	73	10
Ivy Bridge mine East Huel Rose Great Huel Baddern Huel Carpenter Anna Consols, &c.	...	...	935	0

The increasing value of the sulphurets of zinc has naturally led to a considerable increase in the production of this ore. The above list is not to be regarded as representing all the "Black Jack" raised, but the quantities sold from the mines named; it is hoped that in another year these returns will be yet more complete.

Zinc imported into the United Kingdom in the year ending 31st Dec. 1855, and the two previous years:—

	1855.	1854.	1853.
Spelter . .	17,845 tons.	19,583 tons.	23,419 tons.

The zinc in 1855 was chiefly imported from the following places:—

	Zinc or Spelter.	Oxide of Zinc.	
	Tons.	Tons.	cwts.
Prussia	5751	10	0
Hanseatic Towns	7568	...	...
Belgium	3421	176	0
Holland	707	32	14
France	167	5	12
United States	267	12	8

Zinc exported from the United Kingdom in the year ending 31st Dec. 1855, and the two previous years:—

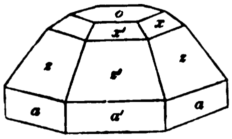
Produce of the United Kingdom.

	1855.
Zinc or spelter	2516 tons.

Order XIX. CADMIUM.

239. GREENOCKITE.—Cadmium Sulfuré, *Dufrénoy.*

Rhombohedral. Hexagonal. Cleavage distinct parallel to *a*, indistinct parallel to *o*. The faces *i*, *x*, *z*, *v* are usually hemihedral, that is to say, wanting at the other, or corresponding termination of the crystal. Translucent, sometimes transparent, opaque. Lustre adamantine, inclining to resinous.



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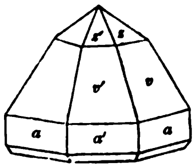
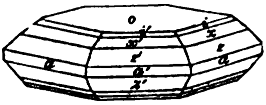


2

a o	90° 00′
a a′	120 00
i o	154 32
x o	136 23
z o	117 42
v o	114 42
x x′	139 38
z z′	127 27



3

Colour honey-yellow, orange-yellow, brown. H. 3 to 3·5; Gr. 4·8 to 4·9. Index of refraction = 2·688.

Combinations: ***azx***; ***avz***; ***aovx***; ***aoxz***; ***aoixz***; ***aoxzv***; ***aoixzv***.

In the matrass decrepitates and turns red, recovering its yellow colour on cooling. With soda on charcoal it deposits a reddish-brown sublimate, soluble in hydrochloric acid with evolution of sulphuretted hydrogen.

Analysis, from Bishoptown, by Connell:—

Cadmium	77·30
Sulphur	22·56
	99·86

Ćd; with cadmium, 77·7; sulphur, 22·3.

This beautiful and rare species was found in cutting a railway tunnel at Bishoptown, near Paisley, in Renfrewshire, and has not been since met with there. It occurred usually in small but very perfect and brilliant crystals, generally insulated, engaged in a porphyritic greenstone, on mammillated Prehnite, associated with calcite, natrolite, and occasionally galena. The largest crystals were not more than a quarter of an inch or thereabouts in diameter, generally very minute.

The species is named in compliment to Lord Greenock, now Earl Cathcart, by whom it was first noticed.

The first crystal of Greenockite was found by the late Mr. Brown of Lanfine House, nearly fifty years ago, on the north side of the Clyde, and was by him taken for blende; this crystal was more than half an inch across. It has lately been occasionally refound at Bowling quarry near Old Kilpatrick, and other localities north of the Clyde, by Dr. Heddle, Professor R. D. Thomson, and others.

In the first volume of the 'Zeitschrift für die gesammten Naturwissenschaften,' published in Halle in 1853, p. 346, there is an article by Schüler on the artificial formation of this substance.

Order XX. CHROMIUM.

240. CHROME OCHRE.—Oxide of Chrome.

Occurs in a pulverulent state, and in loose earthy masses, disseminated and investing. Opaque, dull. Colour grass-green to sisken or yellowish-green; sometimes bright yellow.

Infusible *per se*. With borax forms an emerald-green mass.

Analyses: *a*, from Creuzat in France, by Drappiez; *b*, from Halle, by Duflos:—

	a.	*b.*
Silica	64·0	57·0
Chromic oxide	10·5	5·5
Alumina	23·0	22·5
Peroxide of iron	...	3·5
Water	...	11·0
	97·5	99·5

Formula, $(\dddot{\bar{F}}e, \dddot{\bar{C}}r, \dddot{Al})\dddot{Si}^2$.

Rarely pure; usually mixed with the substance of the rock. The pure oxide of chromium ($\dddot{\bar{C}}r$) contains,—

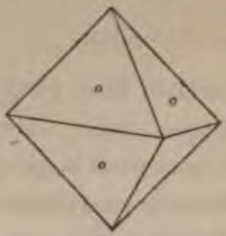
Chromium	68·6
Oxygen	31·4
	100·0

Occurs sparingly, dispersed in small fissures of chromate of iron in Unst, Shetlands, of a bright yellow and pale-greenish colour, probably nearly pure.

241. CHROMITE.—Chromite, *Brooke* and *Miller*; Chromate of Iron, *Phillips*; Fer Chromaté, *Hauy*; Chromeisenstein, *Hausmann*; Chromeisenerz, *Naumann*, *G. Rose*; Chromit, *Haidinger*, *v. Kobell*.

Cubic. Cleavage *o* traces. Fracture imperfect, conchoidal to uneven. Semi-metallic lustre, inclining to fatty. Opaque; occasionally magnetic. Brownish-black. Streak brown. Brittle.

H. 5·5; Gr. 4·4 to 4·5. Rarely crystallized; in grains and granular masses; usually disseminated.



o o 109° 28′

Before the blowpipe unchanged and infusible,—the non-magnetic varieties, however, become magnetic after exposure to the reducing flame; with borax and salt of phosphorus exhibits the reactions of iron and chrome; fused with saltpetre it gives a yellow solution in water, from which the reaction of chromic acid may be obtained. Scarcely acted upon by acids.

There are few species whose chemical constitution is not ascertained with more accuracy than that of chromite, in which it is not yet well made out whether or not both the protoxide and the peroxide of chrome are present.

Analyses: *a*, crystallized, from Baltimore, Maryland, by Abich; *b*, compact, from Beresof, by Moberg:—

	a.	*b.*
Oxide of chrome	60·04	58·40
Alumina	11·85	10·83
Protoxide of chrome . .	...	5·17
Protoxide of iron . . .	20·18	18·42
Magnesia	7·36	6·68
Silica	...	0·91
	99·43	100·41

$\dot{\mathrm{R}}\ddot{\text{Ɍ}}$, in which $\dot{\mathrm{R}}$ is $\dot{\mathrm{F}}\mathrm{e}$,$\dot{\mathrm{M}}\mathrm{g}$ & $\dot{\mathrm{C}}\mathrm{r}$, and $\ddot{\text{Ɍ}}$ is $\ddot{\text{Ȼ}}\mathrm{r}$,$\ddot{\text{Ⱥ}}\mathrm{l}$, and perhaps $\ddot{\text{Ꞙ}}\mathrm{e}$.

On the supposition that Moberg's view of the constitution of chromite is the correct one, its composition would be one in which the $\ddot{\text{Ⱥ}}\mathrm{l}$ and $\ddot{\text{Ȼ}}\mathrm{r}$ contain at least thrice the amount of oxygen contained in the $\dot{R}$ bases, and this is very nearly the case in Abich's analysis given above. The result would then be,—

Oxide of chrome	57·72
Alumina	11·85
Protoxide of chrome . . .	2·08
Protoxide of iron	20·18
Magnesia	7·36
	99·19

LOCALITIES.—*Scotland.* Aberdeenshire; in the parishes of Kildrum and Towie. Banffshire; in limestone, near Portsoy. Perthshire; near Ben Lawes, and at Corriecharmaig, in Glenlochy. Stirlingshire; at Buchanan. At Swinaness and Haroldswick, in Unst, one of the Shetlands, it occurs massive in considerable quantity. It was here that Dr. Heddle, of Edinburgh, discovered octahedral crystals of this species three-eighths of an inch in diameter; at Haroldswick these crystals were imbedded in foliated pennine; at Swinaness they studded the surface, or occurred rarely in the mass of the chromite itself. Chromite occurs likewise in Unst in considerable quantities, disseminated in a yellowish decomposed serpentine, and with pennine, Kämmererite, and emerald nickel. The chief localities in Unst are at Balta Sound, Haroldswick, Loch of Cliff, west of Hagdale, and at Buness House. Also in Fetlar, and in other of the smaller Shetland Islands.

Chromite is an important mineral in the preparation of colours. The first process is to fuse it with saltpetre, whereby chromate of potash is formed, and from this chrome-green and chrome-yellow are prepared.

SUPPLEMENT.

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1. APJOHNITE.

A metallic ore of a brownish leaden colour, mixed with iron pyrites, from Ireland, afforded Dr. Apjohn:—

Sulphuret of iron	24·97
(Mechanical) do.	7·33
Sulphuret of lead	19·13
Sulphuret of zinc	46·62
	98·05

Deducting the *mechanical* sulphuret of iron, and allowing the same loss, these proportions are,—

Bisulphuret of iron	26·99
Sulphuret of lead	20·68
Sulphuret of zinc	50·38
	98·05

atoms.

or, $\overset{\prime}{\mathrm{Fe}}$ 26·98 = 359 = 5

$\overset{\prime}{\mathrm{Pb}}$ 20·67 = 138 = 2

$\overset{\prime}{\mathrm{Zn}}$ 50·37 = 830 = 12,

which gives $5\overset{\prime\prime}{\mathrm{Fe}} + 2\overset{\prime}{\mathrm{Pb}} + 12\overset{\prime}{\mathrm{Zn}}$.

The calculated per-centages, according to Heddle, being,—

$\overset{\prime\prime}{\mathrm{Fe}}$ 5 atoms = 3750 = 26·75 per cent.

$\overset{\prime}{\mathrm{Pb}}$ 2 „ = 2989 = 21·32 „

$\overset{\prime}{\mathrm{Zn}}$ 12 „ = 7279 = 51·93 „

100·00

This close agreement (taking into consideration the loss) with the analysis, and the peculiar colour of the mineral, may perhaps permit this substance to rank as a distinct species. It is to be regretted that fuller information respecting it has not been within reach of the Authors.

TOLITE.—Talc (in part).

metimes veined or mottled. Translucent on edges. ish, or yellowish-green, brownish yellow. Soft; th the nail. Unctuous to the touch. H. 1·5 ; Gr. 2·8.

tore th blowpipe on charcoal whitens and presents some marks of fusion, and with borax affords a colourless s. Partly soluble in sulphuric acid.

nalyses: *a*, from ggan ead-mine, by the Rev. J. A. Galbraith; *b*, from China; *c*, from Nagyag, both by Klaproth; *d*, from China, by John:—

	a.	*b.*	*c.*	*d.*
Silica	50·00	54·50	55·0	55·50
Alumina	33·93	34·00	33·0	31·00
Oxide of iron . .	...	0·75	0·5	1·25
Potash	7·17	6·25	7·0	5·25
Lime	traces	...	...	2·00
Magnesia	1·53	...	...	
Soda	0·90	...	...	...
Water	4·79	4·00	3·0	5·00
	98·32	99·50	98·5	100·00

$4\ddot{Al}\dddot{Si}+\dot{K}\dddot{Si}^2+3\dot{H}$; with silica, 52·80; alumina, 33·06; potash, 9·00; water, 5·14.

LOCALITIES.—Said to occur at Glyder Bach in Carnarvonshire.

At the Royal Iron mines, near Lostwithiel, Cornwall, of a pale flesh-colour.

Ireland.—At the Lugganure lead-mines, Co. Wicklow, of a pale green colour.

3. BOLE.—Bolus. Erinite, *Thomson*; Rhodalite, *Thomson.* Rock Soap. Fuller's Earth. Clay (in part).

The term *Bole* is applied, perhaps rather widely, to several nondescript-looking minerals. Characteristics; massive, earthy. Lustre weak. Colour brown, grey, red, or yellow. Streak shining, greasy. Opaque. Unctuous to the touch. Adheres to the tongue. H. 1·0 to 1·5; Gr. 1·5 to 2·2.

Not fusible *per se* before the blowpipe, but gives off water. Imperfectly dissolved in acids.

Analyses: *a* (Erinite), by Thomson; *b* (rhodalite), by Thomson; *c* (Fuller's earth), Nutfield, Surrey, by Klaproth; *d* (rock soap), by Berthier; *e* (bole), by Löwig:—

	a.	*b.*	*c.*	*d.*	*e.*
Silica	47·0	55·9	53·0	44·0	41·05
Alumina	18·0	8·3	10·0	22·0	25·03
Peroxide of iron	(6·4 Ḟe)	11·4	9·0	...	8·09
Lime					0·45
Magnesia	...	1·7	...	2·0	0·50
Oxide of manganese	...	traces	...	(6·0 sand)	...
Water	25·0	22·0	24·0	25·0	24·02
	96·4	99·3	96·0	99·0	99·14

a. Erinite. Colour yellowish-red, occasionally greenish. Compact, fine-grained. Fracture small conchoidal. Opaque. Lustre slightly resinous. Feel, soapy. H. 1·75; Gr. 2·04.

Before the blowpipe whitens, but does not fuse.

LOCALITIES.—Occurs in amygdaloidal rock, four miles east of the Giant's Causeway; also at Magee Island, near Larne, at the Causeway, at Ballintoy, and at Dunluce Castle, all in Antrim.

b. Rhodalite. Colour rose-red to flesh-red. Texture earthy, soapy. Easily receives a polish and is scratched with the nail. H. 2·0; Gr. 2·0.

Before the blowpipe does not, according to Thomson, fuse *per se*.

Occurs in Co. Antrim with earthy calcite and chabasite in the cavities of amygdaloid, at Ballintoy, at the Causeway, and at Port Bradden, in nodules of a pale flesh-colour; Co. Derry, at Magilligan.

Note.—According to Portlock, rhodalite contains less iron than Dr. Thomson states, and also readily fuses before the blowpipe, intumescing slightly; and with nitre indicates traces of manganese: there is a capital series of this substance in the collection of the Irish Ordnance Survey.

c. Fuller's Earth. Occurs massive, usually of a greenish-brown colour, or greenish-grey. Opaque, soft, dull, with an earthy fracture and greasy feel. Receives a polish with the nail. Hardly adheres to the tongue. Gr. 2·0.

Fusible into a porous slag. In water becomes translucent, and falls into a pulpy impalpable powder. When very pure contains about 45 silica, 20 alumina, and 25 of water. It was formerly much used by fullers in the manufacture and cleaning of wool on account of its great power of absorbing grease and oil, when it forms a kind of earthy soap.

LOCALITIES.—*England.* Bedfordshire; at Apsley.

Buckinghamshire; at Wavendon near Woburn.

Berkshire; at Catsgrove near Reading.

Kent; at Deptling near Maidstone.

Somerset; at Old Down near Bath.

Surrey; at the "Cormongers" and "Cockney" pits; at Nutfield near Reigate, and at Bletchingley.

Sussex; at Tillington and Petworth.

Scotland.—Morayshire; in sandstone at Quarry Wood. Peebles-shire; at Bridgehouse.

d. Rock Soap. Occurs in nodules of a greenish-grey or brown colour in basalt, in the Isle of Skye, and in the trap-rocks of Antrim. It has a greasy feel; adheres slightly to the tongue, and falls to pieces in water. No analysis having been published, it is perhaps liable to be confounded with other similar substances, such as conite; the magnesian carbonate of lime, from Antrim; erinite, &c.

4. CALCAREO-SULPHATE OF BARYTES, *Thomson*.

Is merely barytes: Dr. Heddle finds that weak acid dissolves out the lime from the Strontian mineral, and leaves the barytes in laminated crystals.

5. CALCAREO-SULPHATE OF STRONTIAN, *Thomson*.

Has also been called *Cliftonite*, from near Bristol; it is impure celestine.

6. DORANITE, *Thomson*.

A doubtful zeolitic mineral in aggregated crystals, apparently cubic; colour yellowish-white, and translucent. Sp. Gr. 2·15.

Analysis :—

Silica	48·00
Alumina	22·00
Protoxide of iron	2·75
Lime	6·00
Magnesia	13·00
Water	7·70
	99·45

Perhaps allied to analcime; but having magnesia instead of soda. In basalt, two miles west of Carrickfergus, Co. Antrim.

7. LEEDSITE.—Baryto-calcite, *Thomson*.

Lustre silky. Texture foliated. Colour white, translucent on the edges. Brittle and frangible. H. 4·0; Gr. 3·87.

Composition :—

Sulphate of lime	71·9
Sulphate of baryta	28·1
	100·0

Evidently a mechanical mixture of gypsum and barytes. Occurs between Leeds and Harrowgate in a rock connected with the millstone grit and mountain limestone.

8. MINERAL CHARCOAL.

Occurs in thin layers or filaments, like woody fibre, in the coal-fields of Tyrone, and at Bendurb in Ulster.

At Whitehaven in Cumberland. Occasionally in the sandstones and millstone grit of the coal-formation.

Throughout the Scotch coal-fields, generally in imbedded patches in splint coal. Is carbon, nearly pure.

9. NITROCALCITE.—Nitrate of Lime.

In efflorescent silken tufts and coatings. Colour white or grey. Taste sharp and bitter. On red coal slowly fuses with a slight detonation, and dries; very deliquescent before being heated.

Contains,—

Lime	30·86
Nitric acid	59·26
Water	9·88
	100·00

$\dot{\mathrm{C}}\mathrm{a}\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{N}}+\dot{\text{Ħ}}$.

Found on old walls, in limestone caves, or on spots of earth where the soil is highly calcareous.

10. PIPE CLAY.

Has a greyish or yellowish-white colour. Texture earthy; feel, greasy. Adheres strongly to the tongue. Plastic and tenacious. Infusible.

Composition of a Devonshire specimen by Berthier:—

Silica	57
Alumina	43
	100

$\dddot{\mathrm{A}}\mathrm{l}^{2}\dddot{\mathrm{S}}\mathrm{i}^{3}$; with silica, 57·42; alumina, 42·58: being identical in composition with the ash of Torbanite.

Is manufactured into tobacco-pipes, and is the basis of the Queen's-ware pottery.

Localities.—At Bovey Heathfield, and at Wear Gifford in Devonshire.

Dorset; a large stratum of it lies over the chalk extending from Handfast Point to beyond Corfe Castle; in the hills near Poole, and at Hunger Hill near Wareham.

11. POTTER'S CLAY.

Plastic. Disintegrates on exposure. Colour reddish, brownish, bluish; soft, with unctuous feel. Very infusible.

A variety from Hampshire gave,—

Silica	52
Alumina	25
Lime	3
Water	20
	100

$5\dddot{\bar{A}}l\dddot{S}i^{2}+2\dot{\bar{H}}$; with silica, 51·39; alumina, 28·58; water, 20·03.

Mixed with sand, it is made into bricks and tiles. Most of that used in the Staffordshire potteries is said (about 20,000 tons) to come from Kingsteignton, near Teignmouth, in Devon, and is probably found there among the beds of red marl.

A large quantity, used for common purposes, is obtained in the Isle of Purbeck, Dorset.

With the plastic clay near Reading, Berks.

In some places the upper part of the London Clay is used in coarse potter's work.

Common throughout the lowlands of Scotland.

Potter's earth occurs also in Co. Donegal, and near Clonmel, in Ireland.

12. PIGOTITE.

Professor Johnston describes a compound of alumina with *mudeseous acid,* occurring in caves in the granite of the coast of Cornwall.

Mudeseous acid closely resembles the crenic acid of *Mulder,* and contains $C^{12}H^5O^8$.

This mineral, which can hardly be considered a distinct species, has received the name of *Pigotite,* and is observed in places where the water trickles down over the granite rocks. 'Silliman's Journal,' p. 12, vol. xiii.

13. PLINTHITE, *Thomson.*

Colour brick-red. Texture earthy. Fracture flat conchoidal. Opaque. Does not adhere to the tongue. H. 2·75; Gr. 2·35.

Before the blowpipe *per se* blackens, but does not fuse, or become magnetic.

Analysis by Thomson:—

Silica	30·88
Alumina	20·76
Protoxide of iron	26·16
Lime	2·60
Water	19·60
	100·00

$2\dot{\mathrm{Fe}}^3\dddot{\mathrm{Si}}+3\dddot{\mathrm{Al}}\dddot{\mathrm{Si}}+16\dot{\mathrm{H}}$; with silica, 31·32; alumina, 20·85; protoxide of iron, 28·51; water, 19·37.

Occurs at Down Hill, Co. Antrim; also at the Little Deer Park near Glenarm, in a reddish-coloured trap-rock. Also at Storr, Quirang, and Lyndale in Skye, according to Dr. Heddle.

14. ROTTENSTONE.

Soft, earthy, meagre to the touch; emits an unpleasant odour when rubbed; is of a dirty grey or reddish-brown colour.

According to R. Phillips it contains,—

Alumina	86
Silica	4
Carbon	10
	100

Occurs plentifully near Bakewell, in Derbyshire, and is supposed to arise from the decomposition of the adjacent shale.

It is found also in Wales.

With oil it is used for polishing Britannia metal and other ware.

15. SCARBROITE, *Phillips*; Collyrite, *Freisleben*.

Amorphous. Fracture conchoidal. Adhesive to moist surfaces. Can be polished with the nail. Colour pure white. Devoid of lustre. Breathed on it emits a strong argillaceous odour. Does not fall to pieces in water. H. 2·0; Gr. 1·48.

Analyses: *a*, by Vernon, of Scarbroite; *b*, of Collyrite, from Schemnitz, by Klaproth; *c*, ditto, from Ezquerra, by Berthier:—

	a.	*b.*	*c.*
Silica	10·50	14·0	15·0
Alumina	42·50	45·0	44·5
Peroxide of iron	0·25	...	...
Water	46·75	42·0	40·5
	100·00	101·0	100·0

$\ddot{\mathrm{A}}\mathrm{l}^{3}\ddot{\mathrm{S}}\mathrm{i}+15\dot{\mathrm{H}}$; with silica, 13·77; alumina, 45·97; water, 40·26:—Scarbroite, however, has more water.

Occurs in a reddish-coloured calcareous rock between septa of ironstone, on the Yorkshire coast, near Scarborough.

16. STANNITE, *Breithaupt*.

A mechanical mixture of quartz and oxide of tin, presenting a parasitical or semi-pseudomorphous formation.

It occurred formerly at Huel Primrose, near St. Agnes, both massive and assuming the form of quartz crystals. Colour greyish-white.

Contains, according to Plattner, about 36 per cent. of oxide of tin.

17. SUPERSULPHURET OF LEAD, or JOHNSTONITE.

Massive; opaque. Colour bluish. Lustre metallic. Texture fine granular. H. 3·0; Gr. 6·7.

Contains, according to Johnston,—galena, 90·38; sulphur, 8·71 per cent.

Occurs at Dufton, in Westmoreland; at Alston, in Cumberland, and at Cromford, near Matlock, in Derbyshire.

Also at Glen Malure, in Wicklow.

This species is now shown to be only galena, more or less charged with free sulphur.

18. TUESITE, *Thomson*. Halloysite. Kaolin (in part).

Amorphous. Colour bluish or milk-white. Opaque. Lustre resinous, dull. Sectile. H. 2·3; Gr. 2·5.

Before the blowpipe assumes a light blue colour, and becomes brittle. With carbonate of soda fuses into an opaque mass.

Analysis by Thomson:—

Silica	44·3
Alumina	40·4
Iron, magnesia and lime	1·5
Water	13·5
	99·7

Occurs in new red sandstone on the banks of the Tweed.

It is closely allied to lithomarge, Halloysite and kaolin.

19. VERRUCITE, *Apjohn*.

In rounded globules, rough on the surface, presenting a warty appearance; of a compact structure and reddish-brown colour, from Co. Antrim.

$4\{(\dot{Ca}\dot{Na})\dddot{Si}\}+3\dddot{\bar{Al}}\dddot{Si}+8\dot{\bar{H}}$. Apparently mesolite or Scoulerite.

BRITISH PSEUDOMORPHS

I. NON-METALLIC.

Pseudomorphs.	*Form, or Mineral replaced.*
Quartz	Datholite. Anglesite. Calcite. Fluor. Dolomite. Galena?. Barytes.
Barytes	Witherite. Analcime.
Calcite	Quartz. Galena.
Arragonite	Witherite.
Dolomite	Calc-spar.
Pectolite	Analcime.
Analcime	Laumontite. Calcite?.
Albite (Weissigite)	Laumontite. Analcime. Calcite. Stilbite.
Prehnite	Analcime. Scolezite. Quartz?.
Kaolin	Felspar. Fluor.
Chlorite. Talc	Felspar. Fluor. Axinite. Garnet. Magnetite.
Green Earth	Barytes. Calcite. Augite.
Steatite	Pectolite. Analcime. Barytes. Faroelite.
Mica	Pinite.
Nacrite	Andalusite. Pinite?.
Clay	Rock Salt.

II. METALLIC.

Pyrites	Calcite. Blende. Barytes. Galena. Coal.
Marcasite	Calcite.
Mispickel	Albite?.
Red Iron Ore	Barytes. Calcite. Marcasite. Galena.
Limonite	Iron Pyrites. Göthite. Staurolite. Marcasite.
Siderite	Pyrites. Calcite. Barytes. Fluor. Galena.
Copper Pyrites	Blende. Vitreous Copper. Siderite. Fahlerz

Pseudomorphs.	*Form, or Mineral imitated.*
Vitreous Copper	Native Copper ?.
Buntkupfererz	Vitreous Copper.
Bournonite	Galena ?.
Cuprite	Copper Pyrites.
Chrysocolla	Ruby Copper. Galena. Cerussite. Euclore Mica.
Green Malachite	Cerussite. Ruby Copper. Copper Pyrites.
Galena	Anglesite. Pyromorphite. Barytes.
Cerussite	Leadhillite. Anglesite. Galena.
Pyromorphite	Galena.
Vanadinite	Galena. Silicate of Zinc.
Wolfram	Tungstate of Lime.
Cassiterite	Felspar. Quartz (*Stannite*).
Silicate of Zinc	Galena. Calcite. Vanadinite.
Carbonate of Zinc	Barytes. Calcite. Galena.
Wad	Calcite.
Uran Ochre	Uranite.

LIST OF DEVON AND CORNISH MINES.

NAME OF MINE OR PLACE.	PRODUCE, REMARKS, ETC.	PARISH.	MARKET TOWN.
Wheal Abraham	Copper glance	Crowan	Helstone.
W. Alfred Consols	Silver ores: copper pyrites: arsenio-phosphate of lead: chalcedony: quartz: green malachite.	Phillack	Camborne & Hayle.
Ale and Cakes m.	Barytes: copper (now United mines).	Gwennap	St. Day.
Wheal Ann	Silver ores. carbonate of lead	Gwinear	Camborne & Hayle.
St. Agnes (near)	Bismuth ochre: tin pyrites: topaz: tin ore: felspar: fluor. &c.		St. Agnes.
Alternon	Stream-tin		?
St. Austell Consols	Tin: cobalt: copper: nickel: pitchblende: copper pyrites.	St. Stephens	St. Austell.
Binner Downs m.	Celestine		?
Wheal Betsy	Vivianite		Tavistock.
Buckler's mine	Tin: fine carbonate of iron		St. Austell.
Beam mine	Tinstone, in fine crystals; Wolfram; pharmacosiderite.	Roach	St. Austell.
Huel Boys	Antimony and lead ores: Bournonite.		Endellion.
Botallack mine	Iron, copper and lead ores: tinstone; Göthite; sulphurets of bismuth and copper; native bismuth; specular iron ore; pyrrhotine; axinite; actinolite; schorl; blende; vitreous copper; opal; arseniate of iron.	St. Just	St. Just.
Bedford United m.	Arseniates of copper; olivenite; cuprite; pyrites; siderite.		Tavistock.
S. Wheal Basset	Copper; cuprite; malachite; native and vitreous silver; antunite; uranite.		Redruth.
Wheal Brothers	Silver ores; galena	Calstock	Callington.
Beeralston mine	Fluor; calc-spar; blende; anglesite; galena; pseudo-quartz.	Beerferris	Devon.
Wheal Buckets	Manganese ores; iron; quartz	Pednandrea	Redruth.
Wheal Buller	Copper ores; cuprite; malachite; black oxide of copper; uranite; opal; calc-spar.		Redruth.
Wheal Beauchamp	Specular iron; Göthite; siderite.		Redruth.
Boscawell Downs	Tin ore		St. Just.
Budock Vean m.	Bournonite; galena	Budock	Falmouth.
Black Downs	?		Tavistock.

Pseudomorphs.	*Form, or Mineral imitated.*
Vitreous Copper	Native Copper ?.
Buntkupfererz	Vitreous Copper.
Bournonite	Galena ?.
Cuprite	Copper Pyrites.
Chrysocolla	Ruby Copper. Galena. Cerussite. Euclore Mica.
Green Malachite	Cerussite. Ruby Copper. Copper Pyrites.
Galena	Anglesite. Pyromorphite. Barytes.
Cerussite	Leadhillite. Anglesite. Galena.
Pyromorphite	Galena.
Vanadinite	Galena. Silicate of Zinc.
Wolfram	Tungstate of Lime.
Cassiterite	Felspar. Quartz (*Stannite*).
Silicate of Zinc	Galena. Calcite. Vanadinite.
Carbonate of Zinc	Barytes. Calcite. Galena.
Wad	Calcite.
Uran Ochre	Uranite.

NAME OF MINE OR PLACE.	PRODUCE, REMARKS, ETC.	PARISH.	MARKET TOWN.
Cape Cornwall	Actinolite; jasper; copper and iron ores.		St. Just.
Wheal Crofty (east)	Blende; tremolite	Illogan	Camborne.
Ding Dong mine	Tin; jasper; fluor	Madron	Penzance.
Devon and Cornwall United m.	Childrenite; bismuth ores		Tavistock.
Delabole quarries	Adularia; quartz crystals; albite; rutile.	Tintagel	Camelford.
Dolcoath mine	Cobalt and silver ores; Tennantite; arsenic: cobalt bloom: sulphuret of bismuth; native bismuth; copper pyrites;, fluor; buntkupfererz; pseudoquartz.	Dolcoath	Redruth.
W. Darlington (w.)	Blende		Marazion.
Wheal Druid	Copper ore; Condurrite		Redruth.
Drakewall's mine	Tin and copper ores; Wolfram: molybdena.	Calstock	Callington.
Wheal Duchy	Silver ores, &c. (same as Wheal Brothers).	Calstock	Callington.
Devon Gt. Cons. m.	Copper ores		Tavistock.
Huel Devonshire	Fluor; copper and iron pyrites		St. Agnes.
St. Denis	Mica; wood-tin		St. Austell.
Great Dowgas m.	Tinstone; copper; native, and sulphuret of bismuth; fluor.	St. Stephens	St. Austell.
Wheal Edward	Uranite; pitchblende; copper ores; malachite.		St. Just.
Huel Fortescue	Blende	Gwennap	St. Day.
W. Francis (South)	Cuprite		Redruth.
Wheal Franco	?		Tavistock.
Wheal Falmouth	Vivianite; blende; silver, tin and copper ores.	Kea	Truro.
Wheal Fanny	Vitreous copper; Wolfram (same as Carn Brae mine).	Illogan	Redruth.
Fowey Consols m.	Copper and silver ores; blende; sulphate of iron; pyrites: bismuth glance; siderite; Francolite; antimonite.	Tywardreath	Lostwithiel.
Huel Friendship	Blende; molybdena. (? Marazion.)	Gwennap	St. Day.
Wheal Friendship.	Siderite; galena; Scheelite; quartz; calcite; fluor-spar.		Tavistock.
H. Grambler (Wst.)	Fluor; calcite	Gwennap	St. Day.
Huel Gorland	Arseniates of copper and iron, &c. (now United mines).	Gwennap	St. Day.
Great Consols m.	(Next the St. Day United mine).	Gwennap	St. Day.
Huel Golden	Silver ores; galena; carbonate and phosphate of lead.	Perranzabuloe	Truro.
Garras mine	Galena; pearl-spar; calcite		Truro.
Garth mine	Toad's-eye-tin, in quartz rock		Penzance.
George and Charlotte mine.	Childrenite; chlorite (now Devon and Cornwall United).		Tavistock.
Gunnis Lake mine	Uranite; cuprite; copper ores; Wolfram; libethenite; blue vitriol.	Calstock	Callington.
Great Wheal Vor	Tin and copper ores; mispickel.	Breage	Helstone.

NAME OF MINE OR PLACE.	PRODUCE, REMARKS, ETC.	PARISH.	MARKET TOWN.
Great Polgooth m.	Tin oxide; copper pyrites; cobalt bloom; amethyst; calcite.		St. Austell.
Gavriggan mine	Toad's-eye-tin; wood-tin	St. Denis	St. Austell.
Godolphin Bal	Apatite, in slate near the granite.	Breage	Helstone.
Gwenter or Gwendra ?	Saussurite ? ; bronzite ; diallage ; magnetite.	Nr. Coverack	Lizard Point.
Gt. Hewas Un. m.	Tin and copper ores ; arseniate of copper ; mispickel.	St. Austell	St. Austell.
Hooe mines	(See North Hooe mine)		Tavistock.
Herodsfoot mine	Galena ; pyrites ; barytes ; copper pyrites ; Bournonite ; Fahlerz.		Liskeard.
Huel Harmony	Magnetite ; Wolfram		Redruth.
Holmbush mine	Galena ; copper pyrites ; red silver ; fluor ; silver.	Callington	Callington.
Wheal Hope	Galena ; blue lead	Perranzabuloe	Truro.
Wheal Harriet	Sparable tin		Camborne.
Wheal Herland	Native silver ; sulphuret of silver ; Wolfram ; cobalt pyrites ; sulphuret of bismuth.	Gwinear	Camborne.
Hewas mine	(See Great Hewas United mine) .		St. Austell.
Indian Queen's m.	Manganese ores, &c.	? St. Denis	St. Austell.
St. Ives (near)	Native bismuth ; steatite		St. Ives.
Isaac, Port	Antimony ores		Endellion.
Wheal Jewel	Tennantite, &c. (now in part St. Day United mines).	Gwennap	St. Day.
Wheal Jane	Vivianite ; magnetic pyrites ; nickel ; blende.	Kenwyn ?	Truro.
Wheal James ?	Copper and iron ores ; uranite (? Withiel mine).		Withiel.
St. Just (near)	Asbestus ; chlorite ; schorl ; tourmaline, &c.		St. Just.
Kitt Hill	Wolfram ; moonstone in granite.		Callington.
Huel Kind	Vivianite ; magnetic pyrites		St. Agnes.
Wheal Kayle?	Melaconite ; copper ores	Gwinear	Camborne.
Wheal Kitty	Oxide of tin		St. Agnes.
St. Keverne	Amianthus ......(12 miles from)		Helstone.
Kergillack	Graphite, in granite		Penryn.
Kinance Cove	Diallage ; asbestus ; calcite ; serpentine ; felspar.		Helstone.
Kea (near)	Apatite ; tin ; topaz ; phosphate and carbonate of lead.		Truro.
Lanlivery	Schorl ; stream-tin ; magnetite ; pyrites.	Lanlivery	Bodmin.
Levant mine	Grey copper ; native silver ; tinstone ; vitreous copper.		St. Just.
Lanescot mine	Silver ; blende ; pyrites ; nickel (same as Fowey Consols).	Tywardreath	Lostwithiel.
Wheal Lopez	Copper ores ; siderite.		
Ladock	Stream-tin and gold ; iron ore and red hematite in the mines		Grampound.
Wheal Langford	Silver ores, &c.	Callington	Callington.
Lanarth	Menacconite, &c.		St. Keverne.
Huel Lee	Jamesonite ; antimony ; galena.	Calstock	Callington.
Lemorna Cove	Axinite ; epidote	St. Burien	Penzance.

NAME OF MINE OR PLACE.	PRODUCE, REMARKS, ETC.	PARISH.	MARKET TOWN.
Looe Bar	Carnelian; agate pebbles		Helstone.
Land's End	Tourmaline, in granite	Sennen	Penzance.
Loggan Stone	Schorl		Penzance
Lizard Point	Native copper; felspar; asbestus: steatite; serpentine; magnetite; axinite; quartz.		Penzance.
Letcott	Manganese (at Laneast Down)		Launceston.
Melanoweth mine	Anglesite; galena		Hayle.
Wheal Maria	Copper, &c. (now Devon Great Consols).		Tavistock.
Wheal Maudlin	Tin; copper; Cronstedtite: siderite; magnetic pyrites: mispickel; fluor; sulphate of iron; hematite; opal; garnet: jasper; Wolfram.	Lanlivery	Lostwithiel.
Wheal Marquis	(Now Bedford United mines)		Tavistock.
Wheal Mary Ann	Barytes; fluor; pyrites: galena.	Menheniot	Liskeard.
Mount mine	Blende; copper; tin (now Par Consols).	St. Blazey	St. Blazey.
Wheal Music	Copper ores; cuprite: native copper.	Porth Town	St. Agnes.
Huel Mary	Molybdena; mispickel; cobalt ore.	Lelant.	
Huel Muttrell	Arseniate of iron; copper glance; malachite, &c. (an old mine).		? Redruth.
Wheal Mexico	Silver ores; horn-silver; galena.	Perranzabuloe	
Huel Maggot	Iron ore; Anglesite	Melanoweth.	
Madron	Sphærosiderite: emerystone?	Madron	Penzance.
St. Merryn	Bournonite		Padstow.
Mullion	Saponite (near the Lizard Point).	Mullion	Helstone.
Mainporth	Quartz, primary rhomb in porphyry.	Mainporth	Falmouth.
St. Michael's Mt.	Topaz; tinstone; apatite; Wolfram; lepidolite; felspar; pinite; malachite; copper pyrites.		Penzance.
Marazion (near)	Epidote; asbestus; axinite; eisenkiesel.		Marazion.
St. Mewan	Native silver; gold; wood-tin		St. Austell.
Mawnan Cliffs	Arragonite		Falmouth.
Mount's Bay	Asbestiform actinolite		Marazion, &c.
Mulvra Hill	Pinite, in granite	Sancreed	Penzance.
Menaccon	Menacconite	St. Keverne	Falmouth.
St. Minver Cons. m.	Carbonate of lead		St. Minver.
Nangiles mine	Gold; native sulphur in pyrites	Kea	Truro.
Nanslow	Bournonite		Redruth.
North Hooe mine	Galena; fluor	Beeralston	Tavistock.
Nangisel Cove	Amethyst in drusy cavities, in pinitic granite.	Sennen	Penzance.
North Downs mine	Arseniate of lead		Redruth.
Huel Owls	Specular iron; Schiller-spar; pearl-spar; actinolite; iron ore; tinstone; hornblende.		St. Just.
Penberthy Croft m.	Phosphate of lead		?
Par Consols mine	Tin and copper ores; cuprite; cadmiferous blende.	St. Blazey	St. Blazey.

NAME OF MINE OR PLACE.	PRODUCE, REMARKS, ETC.	PARISH.	MARKET TOWN.
Pendoggett mine	Antimony; Jamesonite	St. Kew	Wadebridge.
Polberrow Cons. m.	Tinstone; wood-tin		St. Agnes.
Huel Park	Tinstone		St. Agnes.
Polgooth mine	Tin crystals; cobalt; amethyst; pearl-spar.	St. Austell	St. Austell.
Wheal Phœnix	Native copper; cuprite; silicate and carbonate of copper; olivenite.	Linkinhorne	Liskeard.
Pengenna mine	Antimony, silver and lead ores.	St. Teath	Camelford.
Wheal Primrose	Carbonate of lead; galena		St. Austell.
Poll mines	Oxide of tin		St. Agnes.
Huel Penrose	Galena; phosphate and carbonate of lead.	Sithney	Helstone.
Wheal Providence.	Mispickel; Uranite; argentiferous mispickel.	Gwinear	Camborne.
Wheal Prosper	Cuprite; grey copper; arseniate of lead.		Falmouth.
Parknoweth mine	Iron ores; Vivianite; specular iron ore.		St. Just.
Huel Pye	Oxide of tin		St. Agnes.
Pool mines	Copper pyrites; chalcedony	Illogan	Camborne.
Poldice mine	Galena; copper; Wolfram (now St. Day United).	Gwennap	St. Day.
Pengelly mine	Nickel ochre; haarkies; mispickel; siderite.	St. Ewe	St. Austell.
Pengelly Croft m.	Scheelite; tinstone	Breage	Helstone.
Prince George m.	Pitchy copper ore; malachite; chrysocolla.	Gwinear	Camborne.
East H. Providence	Tinstone; copper pyrites		Bodmin.
Pentowan	Wood-tin.		
Pentire Glaze m.	Acicular carbonate of lead	St. Minver	Padstow.
Probus	Stream-gold		Truro.
Polaphant	Calc-spar; steatite; serpentine.		Launceston.
Perran Uthnoe	Iron flint, or eisenkiesel		Penzance.
Rosewarne mine	Copper and tin ores; semi-opal.		Camborne.
Wheal Rose (East)	Marcasite; galena (? near Newlyn).	Sithney ?	Helstone.
North Roskear m.	Quartz; jasper; prase; chlorite		Camborne.
Relistian mine	Copper ores; fine native copper; spongy quartz; mispickel.	Gwinear	Camborne.
Royal Iron mines, or Restormel m.	Göthite; hematite; limonite; quartz; lithomarge; amethyst; fine psilomelane.	Lanlivery	Lostwithiel.
Roscommon Cliffs.	Axinite; cobalt bloom		St. Just.
Rocks & Treverby United mines.	Siderite	Roach	St. Austell.
Huel Rock	Tin pyrites	St. Agnes	St. Agnes.
St Day United m.	(See United mines)		St. Day.
Wheal Sparnon	Gold; bismuth ores; cobalt; haarkies; arsenic ochre.		Redruth.
Wheal Scorrier	Rock crystal; tin pyrites	Gwennap	St. Day.
Huel Speed	?		St. Ives.
Silver valley	Silver (gold in Carnon streams)		Falmouth.
South Hooe mine	Galena; fluor-spar		Tavistock.
South Tolgus mine	Copper pyrites		Camborne.

NAME OF MINE OR PLACE.	PRODUCE, REMARKS, ETC.	PARISH.	MARKET TOWN.
Sancreed	Stream wood-tin		Sancreed.
Stenna Gwynn	Fluellite; Gilbertite; Wavellite; fluor; Uranite; opal; Wolfram; granite.	St. Stephens	St. Austell.
South Caradon m.	Copper pyrites; fluor	St. Cleer	Liskeard.
St. Stephens	Grey antimony; stream-tin; magnetite.	St. Stephens	Saltash.
Swan Pool	Quartz crystals	Budock	Falmouth.
Huel Spinster	Common opal		St. Day.
Tuckingmill	Graphite, in granite elvans		Camborne.
Tamar mines	Galena; fluor; carbonate of copper; copper mica; sulphate and carbonate of lead.	Beerferris	Tavistock.
Huel Tolgus	Earthy manganese; copper; amethyst.		Redruth.
Trebartha	Manganese		Launceston.
Tresavean mine	Sulphate of zinc; galena; Fahlerz.	Gwennap	St. Day.
Terrace Hill	Fine garnets and axinite, in a quarry near.		Callington.
Tincroft mine	Tinstone; vitreous copper; purple copper; siderite; Göthite; copper pyrites; Tennantite; hematite.	Illogan	Redruth, Pool.
Ting Tang mine	Arseniates and carbonates of copper and iron; silicate of copper.	Gwennap	St. Day.
Trewether mine	Antimony glance; copper and galena.		Port Isaac.
Trevascus mine	Fahlerz; copper pyrites; chalcedony.	Gwinear	Camborne.
Tintagel Cliffs	Rock crystals; adularia	Tintagel	Camelford.
Wheal Trelawney	Galena; fluor; barytes	Menheniot	Liskeard.
Wheal Trehane	Galena; fluor; barytes	Menheniot	Liskeard.
Trevarthen	Copper; blue vitriol		Marazion.
Trefusis	Copper ores	Gwennap	St. Day.
Trenance mine	Native copper; serpentine	Lizard Point	Helstone.
Trevil mine	Tin; native copper		Bodmin.
Trevannance mine.	Grey copper; fluor; topaz	On the coast,	nr. St. Agnes.
Wheal Trenwith	Uranite; pitchblende; cobalt		St. Ives.
Tolcarne mine	Uranite; pitchblende	Gwennap	St. Day.
Tregonwell	Kaolin ?		Helstone.
Wheal Towan	Siderite; bitumen		St. Agnes.
Wheal Tremayne	Toad's-eye tin; wood-tin; silver; tinstone.	Gwinear	Camborne.
Trevinnock	Antimony ochre; bleinierite; Jamesonite.		Endellion.
Trewellard	Axinite; pinite; brown quartz crystals.		St. Just.
Trugoe mine	Native bismuth; cobalt bloom; semi-opal.	St. Columb [Major.	
Treskerby	Native copper; bitumen, with copper pyrites.		Redruth.
Tregurthy Moor	Toad's-eye tin in quartz rock		St. Austell.
Trannack	Garnet, with copper ore		Helstone.
Treluswell	Magnetite		Penryn.

NAME OF MINE OR PLACE.	PRODUCE, REMARKS, ETC.	PARISH.	MARKET TOWN.
Trethellan	White vitriol		? St. Day.
Wheal Unity	(Now United mines)	Gwennap	St. Day.
St. Day United ms.	Arseniates of iron and copper; uranite; galena; cobalt ochre and cobalt bloom; blende; chrysocolla; cuprite; molybdena; native copper; mispickel; Tennantite; arseniate of lead; malachite; bitumen; fluor; actinolite; chlorite; jasper; tinstone.	Gwennap	St. Day.
Virtuous Lady m.	Anatase; pyrites; siderite; fluor (now Bedford United mines).		Tavistock.
Huel Vincent	Native silver; horn-silver; argentite.	Calstock	Callington.
Huel Virgin	Copper ores (now United mines)	Gwennap	St. Day.
Wheal Vor (Great)	Tinstone; copper ores; mispickel.	Breage	Helstone.
Veryan Point	Oxide of manganese	Veryan	Tregony.
Wherry mine	Cobalt ochre; cobalt glance; tinstone; chlorite.		Penzance.
West Caradon m.	Copper pyrites; native copper.	St. Cleer	Liskeard.
Willsworthy mine.	Cobalt; manganese (6 miles N.W.).		Tavistock.
Withiel mine	Uranite; uran ochre; amethyst.	Withiel	Bodmin.

NOTE.—The above List of Cornish Localities and Mines, as far as it goes, may be considered to be correct; it has been made out with considerable trouble, and may be found occasionally a convenient reference, especially as information respecting Cornish mines is frequently difficult to obtain, and sometimes not to be relied upon. The Authors are under considerable obligations to Mr. R. Talling of Lostwithiel, and to Mr. Garby of Redruth. The mines in this List are mostly those referred to in the body of this work more fully. It will be desirable to bear in mind, that many of the mines here mentioned are old ones, and not now in work, and Cornish mines are constantly changing names. Where the commoner ores or minerals are named, it is to be understood they occur at such or such a mine in a well-crystallized condition, and no criterion is intended respecting the quantity or richness of the ore in any particular mine. Very interesting specimens may sometimes be met with in the old heaps near mines no longer in work.

It may be stated, that the old word *Huel*, prefixed to the names of mines in Cornwall, is no longer used, that of *Wheal* being now almost universally employed.

APPENDIX OF STATISTICS.

No. I.—IRON ORES.

THE most valuable of our iron ores is the *clay ironstone*, on account of the facility with which it is smelted, the clay and lime with which it is mixed materially acting as a flux. This substance, whether under the name of *black band* (when charged with carbonaceous matter), *clay ironstone*, or *argillaceous iron ore*, occurs in almost unlimited quantity in the vicinity of our coal-beds; it is found either in ranges of detached nodules, or in continuous beds. The amount of the protoxide of iron varies in the *spathose iron ore* from 40 to 60 per cent., and in the *clay ironstone* usually from 20 to 40 per cent. Four-fifths of the iron of this country is produced from this variety.

Much interesting information respecting the statistics and nature of iron ores may be found in vol. i. of the 'Illustrated Catalogue of the Great Exhibition of 1851.' Many varieties and qualities, as well as localities, are mentioned in much detail.

About 17,000 tons of Swedish iron are imported into this country annually for conversion into steel, for which, on account of its greater freedom from phosphorus, it is better fitted than British iron. It remains now, however, to be seen, whether the ingenious patent of Mr. Bessemer, after being modified so as to get rid of the phosphorus as yet persistently remaining with the iron, may not enable us to convert the iron of this country into the best steel, and thus to do without any of the Swedish iron hitherto used for that purpose.

The total value of our exports of pig, bar, cast and wrought iron in 1852, amounted to £5,400,000.

It takes nearly four tons of coal to produce one ton of iron, consequently about ten millions of tons of coal are used exclusively for the smelting of iron ore; in addition to about three millions more, required for the conversion of pig-iron into bar-iron.

The finest iron produced in Great Britain is that from the red hematite of Ulverston, in Lancashire, charcoal being principally used for fuel; it contains from 60 to 65 per cent. of iron. The hematite iron ore of the Forest of Dean is also very abundant, and gives a first-rate quality, very suitable for making tin-plate. The crystalline or spathose variety is now becoming every year more employed for smelting, and conversion into the best qualities of steel; large quantities are now being sent from Exmoor, in Somersetshire, to Monmouthshire to be smelted.

The shale resting on limestone near the river Arigna in Roscommon, is remarkably rich in clay ironstones of the first quality. Sir Robert Kane analysed specimens which gave,—

Protoxide of iron	54·42
Lime	2·23
Magnesia	2·02
Alumina	1·43
Clay	8·65
Carbonic acid	31·25
	100·00

The mean of many analyses gave 40 per cent. of metallic iron as the produce of the clay iron ore in that district.

The following Statistics and Tables are taken from Hogg's 'Business Man's Note-Book' for the year 1857:—

The estimated total quantity of iron ore raised in the United Kingdom in the year 1855 was 9,553,741 tons.

This supplied the following blast-furnaces:—

England	311	589;
Wales	156	
Scotland	122	

the produce of iron for the year ending the 31st December, 1855, being—

Pig-iron . . . . 3,218,154 tons.

The mean average price of pig-iron during the year—embracing the varying prices of pig-iron on the Clyde, the more uniform price of the Welsh iron, and the variations of price in Yorkshire and Staffordshire—has been £4 4*s.* the ton; consequently the market value of the pig-iron produced has been £13,516,266.

The following Table shows the distribution of production, as well as character or nature of the iron ore raised, in this country:—

No.	County.	District or Mine.	Character of Iron Ore.	Quantity in Tons
1	Cornwall	Restormel	Hematite.................	20,807
		St. Austell District...	Ditto	2,890
		Helstone District ...	Spathose	250
		North Coast	Hematite.................	110
2	Devonshire	Coombe Martin ...	Spathose	1,190
		South Devon.........	Ditto, &c..................	310
3	Somersetshire ...	Brendon Hills ... Raleigh's Cross... Goosemoor ...... Exmoor	Spathose	4,940
4	Gloucestershire ...	Forest of Dean	Hematite.................	92,608
5	Northamptonsh.	Northampton ... Weedon........... Blisworth	Hydrated Oxide	74,084
6	Staffordshire and Worcestershire	Coal-measures generally	Argillaceous Carbonate	2,500,000
7	Shropshire	Donnington Wood, &c.......	Argillaceous Carbonate	365,000
8	Derbyshire	Sundry Iron Beds	Argillaceous Carbonate, &c. ...	409,500
9	Yorkshire West Riding ...	Ditto	Ditto	255,000
	Yorkshire North Riding ...	Valley of the Esk and Pickering	Carbonate and Oxide...	55,000
		Coast N. of Whitby	Carbonate	50,000
		Cleveland District	Ditto	865,300
10	Northumberland and Durham	Weardale .... Alston .... Haydon Bridge... Tyne District ...	Argillaceous Carbonate, &c. ...	185,000
11	Cumberland	Whitehaven	Hematite.................	200,788
12	Lancashire	Ulverston	Ditto	336,828
13	North Wales ...	Carnarvonshire... Flintshire	Ditto	1,320
		Denbighshire	Argillaceous Carbonate	64,500
14	South Wales	Anthracite District	Argillaceous Carbonate	160,500
15	Ditto	Bituminous District	Argillaceous Carbonate	1,505,000
16	Scotland	Coal-measure Districts generally	Argillaceous Carbonates and Black Band	2,400,000
17	Ireland	Wicklow	Hematite.................	576
18	Isle of Man.........	Douglas, &c.	Hematite.................	2,240
				9,553,741

Iron Imported into the United Kingdom in the Year ending 31st December, 1855, and the two previous Years.

	1855. Tons.	1854. Tons.	1853. Tons.
Iron in bars, unwrought . .	37,407	41,745	47,776
Steel, unwrought	971	1,409	1,362

Iron Exported from the United Kingdom in the Year ending 31st December, 1855, and the two previous Years.

Produce of the United Kingdom.

Produce.				Declared Value.		
	1855. Tons.	1854. Tons.	1853. Tons.	1855. £	1854. £	1853. £
Iron, pig	293,584	293,432	333,585	1,080,108	1,244,853	1,056,310
Bar, bolt, and rod ...	542,754	616,718	653,902	4,626,410	5,731,671	5,647,773
Wire......................	5,919	7,937	9,912	125,936	168,490	201,842
Cast iron	69,861	69,348	60,979	659,632	727,428	576,814
Wrought iron	167,483	188,445	182,606	2,395,626	3,120,381	2,680,550
Steel, unwrought......	16,678	20,793	20,288	585,174	681,852	684,133

No. II.—COAL.

1. *Bituminous coal.*—The most common bituminous coal, and that best adapted for domestic purposes, is found chiefly in Northumberland and Durham; it burns easily and with much flame, and cakes slightly when burning; it contains about 57 per cent. of carbon and 37 of volatile matter, with 5 per cent. of ash.

Very bituminous coal, that does not cake or swell in the fire, occurs principally in Staffordshire, Derbyshire and North Wales; this is of capital quality, and gives out much heat and light, but is not considered so good for domestic purposes as that from Newcastle.

The variety best adapted for the manufacture of iron occurs in South Wales; it contains much carbon and very little volatile matter, such as bitumen, and little ash. It burns freely and without smoke; it is known as *steam-coal*, and the inferior variety is called *culm*. It contains 84 per cent. of carbon, 13 of volatile matter, and 3 of ash.

2. *Unbituminous coal, anthracite,* &c.—There are different opinions about anthracite having any distinct cleavage or not: it often forms columnar masses with axes at right angles to the plane of contact. It has an organic origin, frequently occurring where igneous rocks have intruded on common or brown coal, appearing in fact as its coke, while the volatilized bitumen may be found impregnating the superimposed rocks.

Many varieties thus show a vegetable structure under the microscope, as that from Vaternish Head, Skye. The carbonaceous matter dispersed through the older stratified rocks is in general [illegible]ved to anthracite, as in the clay-slates and grauwackes of the south of Scotland. It is found in trap and other igneous rocks, as claystone porphyry, at the Calton Hill, Edinburgh; Binney Craig, Uphall, and elsewhere.

3. *Lignite* is intermediate between wood and coal. It contains from 30 to 40 per cent. of carbon, from 8 to 16 per cent. of ash, and from 50 to 60 per cent. of volatile matter. The economic value of lignite is two-thirds that of bituminous or black coal; the heat is more diffused but less intense. The British lignite is much inferior to that of Germany; it is, however, used as fuel by the peasants on the shores of Loch Neagh, in Ireland; and at Brora in Sutherlandshire, Scotland; but its "*reek*" is offensive.

TABLE I.—*Showing the weight of Water evaporated by one pound of each of the several principal varieties of Coal.*

	lbs.	ozs.	
Common Scotch (bituminous)	5	14	of water.
Hastings's Hartley Main, Newcastle	6	14	„
Carr's West Hartley, do.	7	5	„
Merthyr, S. Wales (bituminous)	8	0	„
Llangenech (steam-coal)	8	14	„
Cameron's do., South Wales	9	7	„
Pure Welch (anthracite)	10	8	„
Impure do. (do.)	7	15	„

TABLE II.—*Showing the proportional areas of Coal Land in different Countries.*

Countries.	Entire area in square miles.	Square miles of coal land.	Proportion to whole area.
Great Britain, Ireland, Scotland and Wales...	120,229	11,859	$\frac{1}{10}$
Spain (Asturias region)	177,781	3,408	$\frac{1}{52}$
France	203,736	1,719	$\frac{1}{118}$
Belgium	11,372	518	$\frac{1}{22}$
Prussia	107,937	?	
Austria	150,000	?	
The United States of America	2,280,000	133,138	$\frac{1}{17}$
The twelve principal coal states	565,283	133,132	$\frac{1}{4}$
Pennsylvania, U.S.	43,960	15,437	$\frac{1}{3}$
British provinces of New Brunswick, Nova Scotia, Newfoundland	81,113	18,000	$\frac{1}{4}$

Pseudomorphs.	*Form, or Mineral imitated.*
Vitreous Copper	Native Copper?.
Buntkupfererz	Vitreous Copper.
Bournonite	Galena?.
Cuprite	Copper Pyrites.
Chrysocolla	Ruby Copper. Galena. Cerussite. Euclore Mica.
Green Malachite	Cerussite. Ruby Copper. Copper Pyrites.
Galena	Anglesite. Pyromorphite. Barytes.
Cerussite	Leadhillite. Anglesite. Galena.
Pyromorphite	Galena.
Vanadinite	Galena. Silicate of Zinc.
Wolfram	Tungstate of Lime.
Cassiterite	Felspar. Quartz (*Stannite*).
Silicate of Zinc	Galena. Calcite. Vanadinite.
Carbonate of Zinc	Barytes. Calcite. Galena.
Wad	Calcite.
Uran Ochre	Uranite.

LIST OF DEVON AND CORNISH MINES.

NAME OF MINE OR PLACE.	PRODUCE, REMARKS, ETC.	PARISH.	MARKET TOWN.
Wheal Abraham	Copper glance	Crowan	Helstone.
W. Alfred Consols.	Silver ores; copper pyrites; arsenio-phosphate of lead; chalcedony; quartz; green malachite.	Phillack	Camborne & Hayle.
Ale and Cakes m.	Barytes; copper (now United mines).	Gwennap	St. Day.
Wheal Ann	Silver ores; carbonate of lead	Guinear	Camborne & Hayle.
St. Agnes (near)	Bismuth ochre; tin pyrites; topaz; tin ore; felspar; fluor, &c.		St. Agnes.
Alternon	Stream-tin		?
St. Austell Consols	Tin; cobalt; copper; nickel; pitchblende; copper pyrites.	St. Stephens.	St. Austell.
Binner Downs m.	Celestine		?
Wheal Betsy	Vivianite		Tavistock.
Buckler's mine	Tin; fine carbonate of iron		St. Austell.
Beam mine	Tinstone, in fine crystals; Wolfram; pharmacosiderite.	Roach	St. Austell.
Huel Boys	Antimony and lead ores; Bournonite.		Endellion.
Botallack mine	Iron, copper and lead ores; tinstone; Göthite; sulphurets of bismuth and copper; native bismuth; specular iron ore; pyrrhotine; axinite; actinolite; schorl; blende; vitreous copper; opal; arseniate of iron.	St. Just	St. Just.
Bedford United m.	Arseniates of copper; olivenite; cuprite; pyrites; siderite.		Tavistock.
S. Wheal Basset	Copper; cuprite; malachite; native and vitreous silver; antunite; uranite.		Redruth.
Wheal Brothers	Silver ores; galena	Calstock	Callington.
Beeralston mine	Fluor; calc-spar; blende; anglesite; galena; pseudo-quartz.	Beerferris	Devon.
Wheal Buckets	Manganese ores; iron; quartz	Pednandrea	Redruth.
Wheal Buller	Copper ores; cuprite; malachite; black oxide of copper; uranite; opal; calc-spar.		Redruth.
Wheal Beauchamp	Specular iron; Göthite; siderite.		Redruth.
Boscawell Downs	Tin ore		St. Just.
Budock Vean m.	Bournonite; galena	Budock	Falmouth.
Black Downs	?		Tavistock.

The following Table is taken from 'The Business Man's Note-Book,' edited by James Hogg, jun., F.R.G.S., 1857:—

TABLE III.—*Summary of Coal Produce for* 1855.

	Tons.
Durham and Northumberland	15,431,400
Cumberland	809,549
Yorkshire	7,747,470
Derbyshire	2,256,000
Nottinghamshire	809,400
Warwickshire	262,000
Leicestershire	425,000
Staffordshire and Worcestershire	7,323,000
Lancashire	8,500,000
Cheshire	755,500
Shropshire	1,105,250
Gloucestershire, Somersetshire and Devonshire	1,430,620
North Wales	1,125,000
South Wales	8,552,270
Scotland	7,325,000
Ireland	144,260
Total of 1855	64,453,070
Ditto 1854	64,661,401
Decrease	207,331

No. III.—SALT.

The principal part of the salt raised in England is in the valley of the Weaver, in Cheshire. When the salt duty was repealed in 1824, there were seventy-five salt-works where salt was raised in a fossil state, viz.—

34 at Northwich
26 at Winsford
3 at Middlewich } in Cheshire.
2 at Nantwich
2 at Shirleywich, Staffordshire.
6 at Droitwich, Gloucestershire.
2 in Durham.

There were at the same time thirty-five works at which salt was obtained by evaporation from sea-water, twenty-nine of which were in Hampshire, or in the Isle of Wight. In Scotland, at the same time, there were fifteen salt-works, at all of which the salt was made by the evaporation of sea-water.

The process by solar evaporation is now entirely discontinued. The quantity of salt now produced annually is about 500,000 tons, of which rather more than 100,000 tons are in the fossil or rock state, theremainder from brine-springs. The production of other countries may be set down at 100,000 tons.

Rock-salt is often used to strengthen the brine from those springs from which the salt used for domestic purposes in England is made. The Cheshire brine-springs vary from 30 to 40 yards in depth, and are very productive. They were worked at a very early period, but *rock-salt* was not raised in Cheshire in the fossil or solid state until the year 1670. (See the Philosophical Transactions, No. 66, December, 1670.) Other brine-springs occur near Droitwich, in Gloucestershire. Most of the salt raised in Cheshire is exported. In 1824 the quantity of salt sent down the river Weaver was about 435,000 tons.

The quantity of white salt manufactured from brine in the districts of Winsford and Northwich in 1855 was 834,514 tons; and of rock-salt raised, 70,256 tons.

The quantity of salt manufactured from brine at Droitwich and Stoke, 170,000 tons.

At Carrickfergus, near Belfast, there were raised in 1855 about 20,000 tons, of which 8000 were consumed in Ireland.

The declared value of the exports of salt in 1855 was £347,714, the total quantity exported being 630,000 tons, or 25,000,000 bushels. The sources of supply in Cheshire are almost inexhaustible.

The Staffordshire salt is chiefly exported from Hull, and that of Gloucestershire from Gloucester.

The capital engaged in the manufacture of salt amounts to about £1,000,000, and the population engaged in it about 12,000. The retail price is now ½*d.* per lb.; during the duty it was 4½*d.* The average annual consumption of an adult in this country is supposed to be about 16 lbs. The cost of production of the finest Cheshire salt is 3½*d.* to 4*d.* per bushel.

No. IV.—ALUM.

Towards the end of the reign of Elizabeth, Sir Thomas Chaloner established the first alum-work in England, in the vicinity of Whitby, where the chief works of the kind are still carried on. The shipments of alum from Whitby amounted to 3300 tons in 1841. The best alum, however, is that prepared from the alum-stone of Civita Vecchia, near Rome. At Whitby the alum-slate is broken up along with fuel and set on fire. The residual or calcined matter, which consists of earth, oxide of iron, and sulphate of alumina, is lixiviated with water; a solution of the earthy salt being obtained, potash salts are added, and crystals of alum are formed after the liquid has evaporated; it takes 130 tons of calcined alum-shale to produce 1 ton of alum.

The following is from the 'Penny Cyclopædia':—

"Alum is occasionally a recent produce of decomposing sulphurets where alumina and potash are present.

"The stratum of alum-shales near Whitby extends ten miles south of that town, to eighteen miles north of it. The cliffs are in general precipitous, and their height from 100 to 750 feet. The colour of this shale is bluish-green; its hardness varies: at the top part it may be crumbled between the fingers, lower down it is hard as roofing-slate. The specific gravity is about 2·48. By exposure to the air it effloresces and acquires a taste of alum.

"Alum-slate has not been accurately analysed, but it contains silica, alumina, and, before efflorescence, probably some pyrites or bisulphuret of iron. At Hurlet, near Glasgow, and at Campsie, alum is manufactured from what appears to be *clay-slate* impregnated with bisulphuret of iron; it is obtained from old coal-pits, and having been long exposed to air and moisture, sulphate of iron and sulphate of alumina are formed, and in crystallizing completely destroy the texture of the slate. This double sulphuret occurs in the form of soft delicate fibres, nearly colourless, and with a silky lustre. It is readily soluble in water, the solution yielding crystals of sulphate of iron, and when potash salts are added to the remaining solution of sulphate of alumina, crystals of alum are formed; and this is one process of alum-making. According to Phillips this double salt contains,—

Sulphuric acid	30·9
Alumina	5·2
Protoxide of iron	20·7
Water	43·2
	100·0

"When this double salt has been dissolved, the remaining slate is exposed in heaps to the air and moisture, when, by their action upon the pyrites, further quantities of the salt are produced."

The alum-schists raised near Glasgow in 1855 amounted to about 15,000 tons, producing about 6000 tons of alum; and about the same quantity was raised in the neighbourhood of Whitby.

No. V.—PEAT.

This substance, consisting of a mass of more or less decomposed vegetable matter of a brown colour, is closely connected with coal.

It contains,—

Carbon	58·09
Hydrogen	5·93
Oxygen	31·37
Ashes	4·61
	100·00

Mulder has found among the proximate elements of peat four different resins, with humic and ulnic acids. The ashes, besides silica, alumina and peroxide of iron, contain carbonates and phosphates of lime, and chloride of calcium.

Peat shows a great attractive power for moisture. It has been shown that peat has been chiefly formed from five kinds of plants, viz. the *Sphagnum* and similar mosses, the stems and roots of *heaths*, the similar parts of *glumaceous* plants, the wood of *trees*, and lastly, though not constantly, sea-weed or *fuci*.

The Irish bogs are estimated to cover 3,000,000 acres of land.

Various chemical compounds have been obtained from peat; as treated by Stone's process, there were exhibited in the Great Exhibition of 1851 the following substances:—

1. Ammoniacal liquor; the watery product of the first distillation of peat.
2. Sulphate of ammonia; liquid ammonia; acetate of lime, and pyroligneous acid.
3. Paranaphthadipose; the general crude product of the first distillation of peat.
4. Peatole; the heavy oil from paranaphthadipose.
5. Peatine; the peat from the paranaphthadipose.
6. Peupione; the light fatty oil obtained from the peatole.
7. Adiposole, or fatty part of the residue of the distillation of paranaphthadipose.
8. Adipolein, or residue after the distillation of the peatole and peatine.
9. Peacerine; the waxy residuum of re-distillation of adiposole.
10. Paraffine; product of the forced distillation of adiposole.
11. Bisulphuret of carbon, or spirit of sulphur, obtained from sulphur and charpeat.
12. Sulphuretted peat charcoal, after having served to carbonize the spirit of sulphur (fit for making gunpowder).
13. Humic acid; peat timber, obtained from certain peats.
14. Peat charcoal, for deodorizing, or for mixing with manure.
15. Acetate of lime.

16. Chloroform ?.

17. Tar.

The calorific power of good dry turf, or peat, is about one-half that of coal, but it often contains one-fourth of its weight of water even when feeling dry to the hand; this causes a further loss of 25 per cent. in its calorific power.

Peat may be carbonized, and the quantity of charcoal obtained is 27 per cent. of the weight of dry turf.

Blavier found that 1157 lbs. of dried turf contained—

Charcoal . . .	474=41	per cent. (including ashes).
Watery liquid . .	226=19	,,
Tar	7=01	,,
Gaseous matter .	450=39	,,
	1157	

Peat near the surface contains a smaller proportion of ashes than that lower down. To render it more available and less bulky, it is advisable to submit it to hydraulic pressure.

Peat is very frequently coated with a film of phosphate of iron. It would appear that this substance is the product of the first stage of a peculiar fermentative process which has been perfected in coal.

No. VI.—EXTRACTION OF SILVER FROM LEAD-ORE.

Mr. Taylor estimates the average quantity of silver per ton throughout the kingdom to amount to about 12 ounces. He says,—"4 ounces of silver in a ton will by Pattinson's process pay for extraction. Formerly it required from 9 to 15 ounces, varying according to the quality of the lead.

"It appears on the whole that the lead-ore of Devon and Cornwall is the richest, but the greatest proportion I ever knew was lead from the County of Clare, in Ireland, and amounted to 144 ounces in the ton. This ore was from limestone.

"The lead-mines in Wales are in Flintshire and Denbighshire, in limestone with little or no silver, and in Cardiganshire are in clay-slate, some being argentiferous to the extent of 30 or 40 ounces per ton, and others holding no silver worth extracting, so that no rule can be laid down as to the effect of the nature of the rocks containing the veins or deposits. Generally speaking, however, the lead from the older rocks is more argentiferous than from the secondary or stratified rocks.

"No galena has, I believe, been found entirely free from silver." See vol. vii. of the Transactions of the British Association.

In addition to the value of the silver extracted, the lead itself fetches £1 a ton more, the presence of silver rendering it hard and less workable.

The old method of separating silver from lead consisted in repeated oxidations of the surface of the melted lead, the oxidized surface being removed as fast as formed.

This was not only a tedious process, but caused a considerable waste of the lead itself, and it required the ore to be argentiferous to the extent of 9 ounces in a ton to render the extraction of the silver remunerative.

Mr. Pattinson's method, which is now commonly adopted, is based upon the fact that the silver, or any other foreign matter, is rejected from crystallized portions of the lead at the moment of crystallization. Thus by repeated crystallizations and removal of the crystallized parts, a residuum is obtained of mixed silver and lead, sufficiently rich in the former to allow of its being separated in the usual manner by cupellation; and this residuum is considered ready for cupellation when it contains silver in the proportion of from 200 to 300 ounces in the ton. The lead-smeltings at the Allenhead mines, and at the Wanlockhead Hills, Dumfriesshire, are founded on Pattinson's process. The Allenhead Company sent a cake of pure silver, thus obtained, to the Great Exhibition of 1851, weighing 8000 ounces.

TABLE OF THE INDICES OF REFRACTION OF THE MINERALS FOUND IN THE UNITED KINGDOM.

Greenockite	2·688
Pyrargyrite	2·564
Anatase	2·500
Blende	2·260
Plumbago	2·240
Scheelite, *least*	1·970
„ *greatest*	2·129
Sulphur	2·115
Zircon, *least*	1·961
„ *greatest*	2·015
Anglesite	1·925
Garnet	1·815
Cerussite, *least*	1·813
„ *greatest*	2·084
Arsenite	1·811
Hypersthene	1·800
Sapphire	1·794
Pyrope	1·792
Rubellite	1·779
Adularia	1·764
Spinelle	1·761
Cinnamon-stone	1·759
Axinite	1·735
Tourmaline	1·668
Epidote, *least*	1·661
„ *greatest*	1·703
Apatite	1·657
Barytes, *least*	1·646
„ *greatest*	1·664
Sal-ammoniac	1·625
Blue topaz (Aberdeen)	1·636
Colourless, ditto	1·610
Beryl	1·598
Anhydrite, *ordinary*	1·577
„ *greatest*	1·622
Amethyst	1·562
Rock-crystal, *ordinary*	1·548
„ *extraordinary*	1·558
Rock-salt	1·557
Thomsonite	1·553
Chalcedony	1·553
Amber	1·547
Petroleum	1·544
Iolite	1·544
Strontianite, *least*	1·543
„ *greatest*	1·700
Apophyllite	1·543
Witherite	1·540
Felspar	1·536
Arragonite, *ordinary*	1·693
„ *extraordinary*	1·535
Blue vitriol, *least*	1·531
„ *greatest*	1·552
Selenite, *least*	1·525
„ *greatest*	1·536
Calcite, *least*	1·519
„ *greatest*	1·665
Goslarite	1·517
Natrolite, *least*	1·516
„ *greatest*	1·522
Scolezite	1·515
Stilbite	1·508
Melanterite	1·494
Epsomite, *least*	1·465
„ *greatest*	1·488
Obsidian	1·488
Opal	1·479
Naphtha	1·475
Alum	1·457
Fluor	1·436
Water	1·336
Ice	1·308
Cryptoline	1·295
Amethystoline	1·211
Brewstoline	1·131
Vacuum	1·000

ADDENDA.

Agate.—Hollow agates, containing loose nodules of calcite which rattle when the specimen is shaken, are found loose in the soil in Fifeshire.

Amethyst.—Additional localities are—in cavities of agate in Fife, Perth and Forfarshire; Haddingtonshire, on the coast opposite the Bass Rock.

Amethystoline.—This name may be given to the volatile fluid observed by Brewster in cavities of amethyst.

Axinite.—Lately at Terrace Hill quarry, near Callington.

Bismuth Ochre.—Has been lately found by Mr. Richard Talling in the Royal iron-mine, near Lostwithiel, Cornwall.

Brewstoline.—Brewstoline, *Dana*. Fluid. Colourless. Transparent. Expands one-fourth of its bulk by an increment of 30° of Fahr., or is nearly thirty-two times more expansible than water, by an increment of 30° at the temperature of 50°.

Occurs in the blue topaz from Aberdeenshire.

(See further, Edinburgh Royal Transactions, vol. x.)

Brucite.—The locality of Brucite has been refound by Heddle, who has procured magnificent specimens of the mineral; transparent in the laminæ, also *botryoidal*, and rarely crystallized.

Chalcedony.—Yellow and red chalcedony is found at Burn Anne, near Galston, in Ayrshire.

Chlorite.—Occurs in octahedral crystals after magnetite, at South Roskear mine, Camborne.

Cryptoline.—Cryptoline, *Dana*. Occurs along with Brewstoline in the topaz from Aberdeen, as a fluid not miscible with the former, though occurring often in the same cavities. On exposure it hardens speedily into a yellowish transparent resinous substance, not volatilizable by heat, nor soluble in water or alcohol, but rapidly dissolving with effervescence in sulphuric, nitric and muriatic acids.

(See further, Edinburgh Royal Transactions, vol. x.)

Davidsonite.—Davidsonite has been analysed by Plattner with the following results:—

	a.	*b.*
Silica	66·10	67·70
Alumina	14·58	15·64
Glucina	13·02	12·52
Magnesia	4·16	3·10
Protoxide of iron . .	0·52	0·25
Water	0·80	0·16
	99·18	99·27

The analysis under *b* is Heddle's, who thought his specimen contaminated with mica, and from the presence of magnesia concluded that the Rubislaw mica was Biotite and not Muscovite: it may, however, be the case that beryl from this locality contains magnesia as a constituent, though it is not easy to see what it replaces; did it replace glucina, it would be a strong argument in favour of Rammelsberg's view of the constitution of that substance; in both the above analyses, however, the glucina is in nearly full amount.

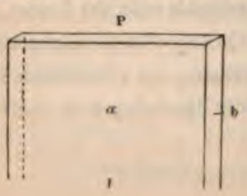
Dimagnetite.—Heddle finds that certain of the needle crystals usually considered Göthite, which occur in the drusy cavities of the porphyritic trap at Gourock in Renfrewshire, are magnetic. He supposes that they may be dimagnetite, and that that substance may not be pseudo after Lievrite, as Dana concludes, but after Göthite. Shepard gives the angle of the prism of dimagnetite 130°; *d* on *d′*, the most usual prism face of Göthite, is 130° 40′: Dana states the angle to have different values, and mentions one 114° 20′, which is near *d* on *a* of Göthite 114° 40′.

Epidote.—Lately found associated with micaceous iron at Hillswickness, in the Shetlands.

Erythrine.—Lately found in minute globules sprinkled over quartz, at Leadhills.

Faröelite.—The form of this mineral has been lately determined by Dr. Heddle on specimens from Faröe and Skye.

Prismatic. Primary form a right rhombic prism. Cleavage *a* highly perfect; *b* perfect; M less so. Lustre *a* pearly; *b*, M and P vitreous.



a b	90° 00′
a P	90 00
P *b*	90 00
a M	116 20 cleavage.

M, a cleavage face. Skye form, *a b* P. Irish forms apparently modified. The position which Faröelite holds in the system is shown by the following Table:—

Thomsonite (normal)	$\dot{\text{C}}\text{a}^3\,\ddot{\text{Si}}+3\overset{\cdots}{\text{Al}}\,\ddot{\text{Si}}+7\dot{\text{H}}$
Soda Thomsonite	$(\dot{\text{N}}\text{a}\,\dot{\text{C}}\text{a}^2)\,\ddot{\text{Si}}+3\overset{\cdots}{\text{Al}}\,\ddot{\text{Si}}+7\dot{\text{H}}$
Faröelite	$(\dot{\text{N}}\text{a}\,\dot{\text{C}}\text{a}^2)\,\dddot{\text{Si}}^2+3\overset{\cdots}{\text{Al}}\,\dddot{\text{Si}}+8\dot{\text{H}}$
Mesolite	$(\dot{\text{N}}\text{a}\,\dot{\text{C}}\text{a}^2)\,\dddot{\text{Si}}^3+3\overset{\cdots}{\text{Al}}\,\dddot{\text{Si}}+8\dot{\text{H}}$
Scolezite	$\dot{\text{C}}\text{a}^3\,\dddot{\text{Si}}^3+3\overset{\cdots}{\text{Al}}\,\dddot{\text{Si}}+9\dot{\text{H}}$

the position, in fact, which we have assigned to it in this work.

Francolite.—The formula for Francolite, $3\dot{\text{C}}\text{a}^3\overset{\cdot\cdot}{\overset{\cdot\cdot\cdot}{\text{P}}}+\text{CaFl}$, gives phosphoric acid, 42·02; lime, 50·29; calcium, 4·02; fluorine, 3·67. $3\dot{\text{C}}\text{a}^3\overset{\cdot\cdot}{\overset{\cdot\cdot\cdot}{\text{P}}}+\text{Ca}(\text{F},\text{Cl})$ gives phosphoric acid, 41·34; lime, 49·48; calcium, 3·96; fluorine, 1·80; chlorine, 3·42. The text at page 77 is wrong.

Garnet.—Fine garnets have been found lately at Terrace Hill quarry, near Callington, in Cornwall.

Guyaquillite.—In Dr. Heddle's collection there is a specimen of a mineral-resin which may be a variety of the above. It occurs with calcite in coal; colour bright yellow; of the consistence of lard, but tenacious; floats on water; melts much below the boiling-point of the latter; burns with a brilliant flame and an aromatic odour, leaving a carbonaceous scoria. Was found at Airdrie.

Hornblende.—Occurs well crystallized in a schistose rock in small crystals, M P *b r*, with the faces M and *b* of unusual length, in the north of Perthshire. These crystals have passed under the name of Breadalbanite.

Malaconite.—Lately found with erythrine at Leadhills.

Muscovite.—Occurs in large plates generally throughout the granitic rocks of the Shetland Islands.

Pentlandite.—Under this name the following analysis by Rivot, of eisen-nickelkies from Craignure, occurs in Dufrénoy's 'Mineralogie' (1856):—Iron, 50·0; nickel, 13·6; sulphur, 13·3.

Phenakite.—A crystal almost identical in appearance with the Uralian phenakite was found by Dr. Heddle at Hillswickness Point, opposite the Drongs, in Shetland. The crystal is imbedded in mica-slate, so that the faces are rough: it may be merely beryl.

Pitch Blende.—Occurs in Cornwall at St. Austell Consols; and has been recently found in a copper lode at Treemoor in the parish of Withiel.

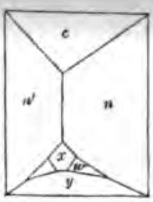
Plattnerite.—The analysis of Plattnerite is exactly the composition of the binoxide of lead, $\dot{P}b$; which has, even when in powder, a deep brown colour, and, according to Boullay, a specific gravity of 9·2: the agreement with the above characters renders more probable its occurrence in nature.

Quartz.—Very fine specimens of stalactitic quartz are found at Kinnoul Hill, Perthshire.

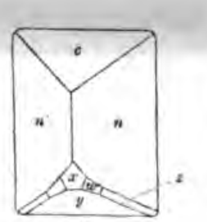
For a description of the formation of the crystals of "Babel quartz," see an article by Professor G. Rose, in Poggendorff's 'Annalen,' vol. c. p. 142.

In the drusy quartz cavities of a trap rock at Ballygroggan, in the Mull of Cantyre, there occurs, disposed on crystals of Göthite, a peculiar substance which appears to contain an organic acid. It is in globules or drops, of a yellowish colour, of the consistence of soap; feels soapy or waxy, and, when heated, gives out some water; burns with a peculiar smell, and is almost entirely dissipated. Occurs in small quantity.

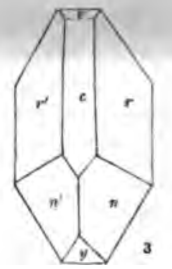
Sphene.—The following additional forms of sphene have been lately observed by Heddle:—



1



2



3

y r	114°	21′		126°	26′	*x z*	164°	49′
y n	114	36	*r r*	113	28	*z z*	149	38
y v	66	58	*n r*	153	24	*z w*	172	32
y x	158	55	*x w*	172	16	*z n*	167	23
y z	154	13	*w w*	164	32	*z r*	140	47

c n y x w; *c n y x w z*; hair-brown from New Abbey near Criffel: *c n y r v*; yellow in quartz, with rutile and chlorite, from Craig Cailleach, Perthshire.

Steatite.—Found lately pseudo after Faröelite, in the Isle of Magee, Co. Antrim, Ireland.

CORRIGENDA.

Page 5, line 8 *from top*, *for* 48·88 *read* 46·88.
„ 7, „ 10 *from bottom*, *for* Rathin *read* Rathlin.
„ 17, „ 2 *from top*, *for* Fife *read* Fyfe.
„ 23, „ 17 *from top*, *for* Cleaton *read* Cleator.
„ 93, „ 10 *from top*, *for* neolitic *read* zeolitic.
„ 94, „ 8 *from top*, *for* Dunnegan *read* Dunvegan.
„ 112, „ 11 *from bottom*, *for* Laumonite and calcite *read* stilbite.
„ 113, „ 16 *from top*, *for* cyanite *read* syenite.
„ „ „ 10 *from bottom*, *for* calcite, analcime and Laumonite *read* stilbite.
„ 114, „ 19 *from top*, *for* eugite *read* augite.
„ 138, „ „ *for* also represents the formula for augite *read* is essentially an augitic formula.
„ 150, *before* analyses; *a*, by Kengott *insert* analyses of the galactite of Haidinger.
„ 168, „ 10 *from top*, *for* Melschter *read* Melsetter.
„ 171, „ 13 *from top*, *for* arcadialite *read* acadialite.
„ 198, „ 2 *from bottom*, *for* c a *read* o a.
„ 233, *place the* 3·40 *in last analysis opposite Boracic acid.*
„ 235, „ 11 *from bottom*, *for* 4·9 *read* 3·9.
„ 244, „ 12 *from top*, *for* dodecahedrons *read* octahedrons.
„ 249, at line 9 *from top*, *insert*, also at the Meadow of the Kaim, Hoy, Orkneys; and generally throughout the sandstones of the coal-measures.
„ 250, line 3 *from bottom*, *for* 4 *read* 2.
„ 254, „ 3 *from top*, *for* in the Sail *read* of the Sail.
„ 262, „ 15 *from top*, *for* Menacconite *read* Menaccanite.
„ 380, „ 7 *from bottom*, *for* Xaphyllite *read* Daphyllite.

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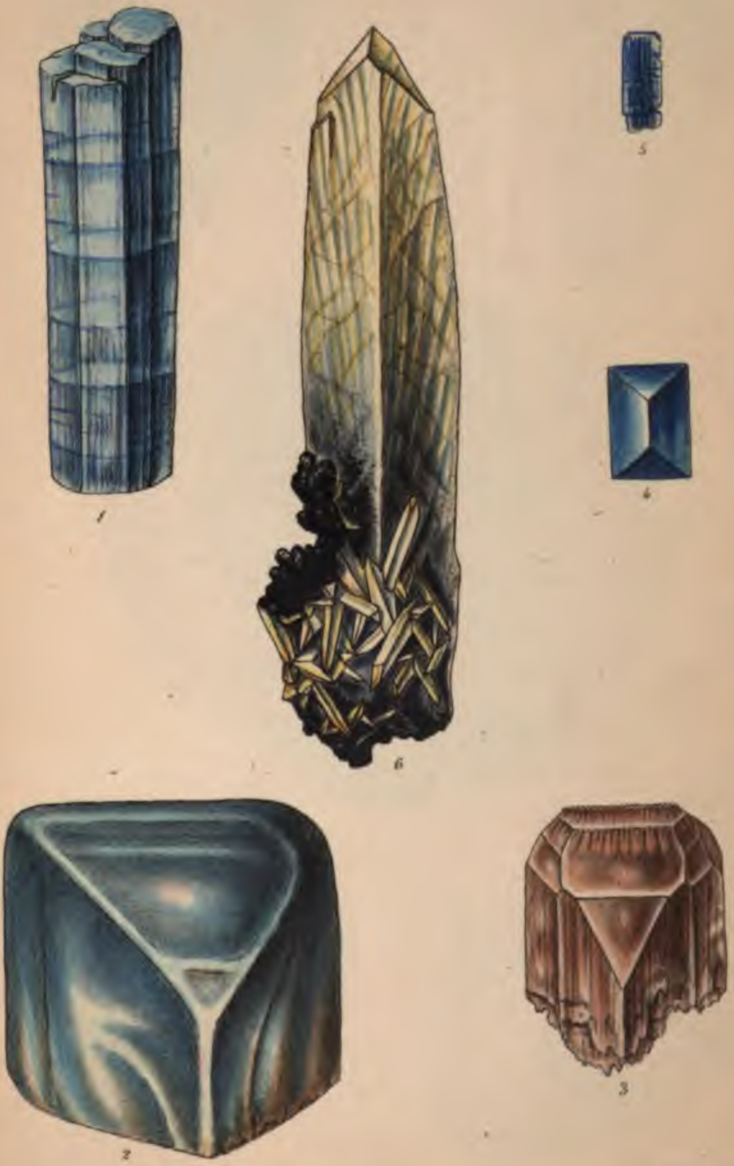

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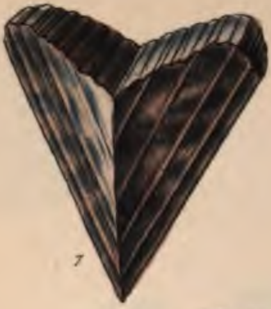
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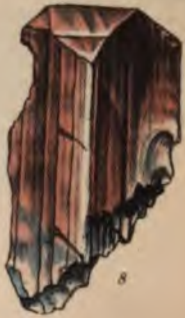
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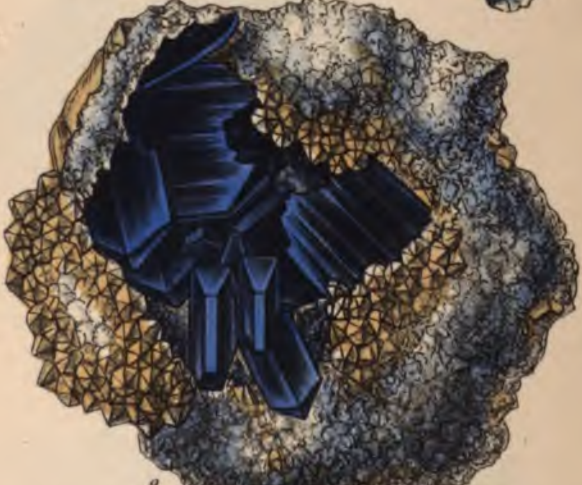
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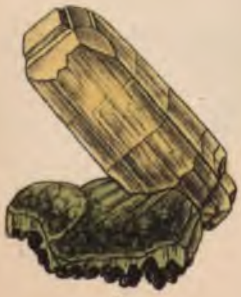
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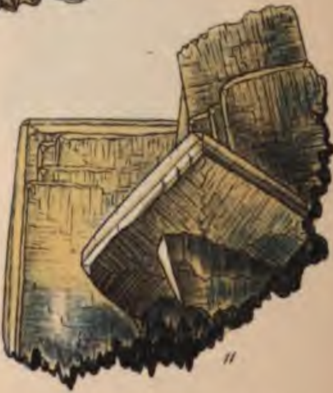
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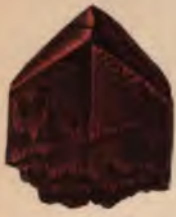

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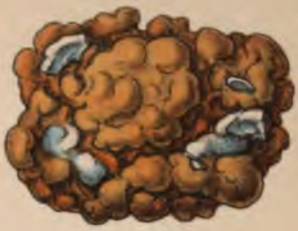

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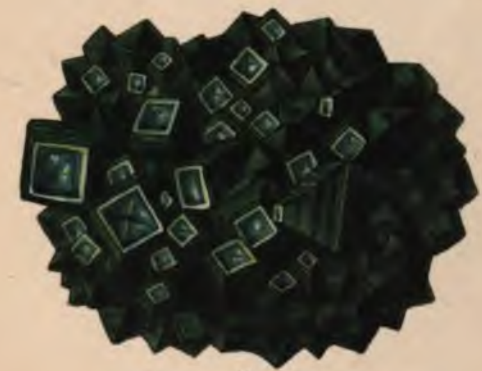

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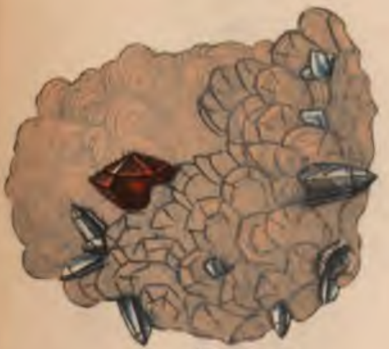

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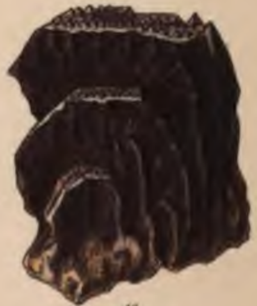

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